STABRO LABORATORIES

Instruction Manual

JOHN FLUKE MFG. CO., INC.

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DOCUMENT CONTROL ADMINISTRATOR

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FLUKE

MODEL 825A

DIFFERENTIAL VOLTMETER

INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO. INC.
P. O. Box 7428 Seattle 33, Washington

April 30, 1962

MODEL 825A
DIFFERENTIAL VOLTMETER

825A 280 & up

825AR 334 & up

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ERRATA AND ADDENDUM

Model 825A

Starting with serial number 825A 380 and 825AR 234, a transistor regulator is used to supply a constant current to the filament of V105 instead of the ballast tube regulator. This transistor regulator improves the stability of the reference supply to ±0.0025% for a ±10% change in line voltage.

Change the "List of Replaceable Parts," Section 5, as follows:

DELETE:

R101	Resistor, wirewound, 10Ω, 5%, 10 W	R10WA
R102	Resistor, composition, 1 Meg, 10%, 1/2W	EB1051
T1	Transformer, power	801B-651
V101	Vacuum tube, filament regulator, 9-7	9-7

ADD:

C106	Capacitor, electrolytic, 1500 uf, -10/+150%, 16V	CE79
CR104	Diode, silicon, 0.750 Amp, 600 PIV	RE18
Q101	Transistor, germanium, PNP, 2N301W	2N301W
Q102	Transistor, germanium, PNP, 2N1372	2N1372
R101	Resistor, deposited carbon, 5 K, 1%, 1/2 W	DR49
R102	Resistor, deposited carbon, 62 K, 1%, 1/2 W	DR817
T1	Transformer, power	801B-652

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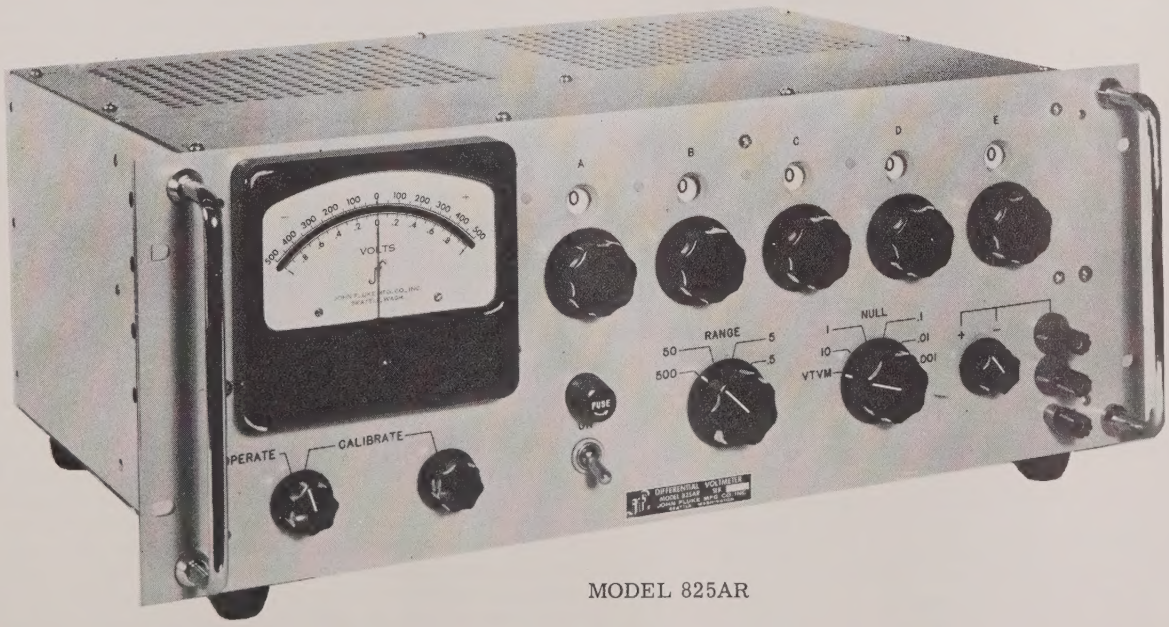
MODEL 825A



MODEL 825AR

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

a. This instruction manual is for use with the 825A and the 825AR Differential DC Voltmeter. Although electrically the same, the 825A is a cabinet model and the 825AR is designed to fit a standard 19" rack. Any difference in the two instruments that affect this manual are so indicated.

b. The high accuracy, portability, and compactness of the 825A make this instrument ideal for the precise measurement of almost any DC voltage. Ease of operation, inherent protection from accidental overload, and high reliability contribute to the outstanding performance that assures suitability for both production line testing and precision laboratory measurements. This instrument is capable of being used as a vacuum tube voltmeter, as a precision potentiometer, and as a megohmmeter for measurement of high resistance. It can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source when balance is attained. Thus the determination of the unknown potential is independent of its source resistance. The 825A is basically used for measurements of DC voltages from 0 to 500 volts. However, high accuracy measurements to 30,000 volts DC are possible with precision voltage dividers especially designed for use with the Fluke Model 800 Series Differential Voltmeters. As additional features, this instrument contains a polarity switch for equal convenience in measuring positive or negative voltages and an adjustable recorder output which makes the 825A particularly useful for monitoring the stability of almost any DC voltage. Furthermore, the 825A meter has taut-band suspension which eliminates problems due to meter stickiness.

c. When used as a differential voltmeter, the 825A operates on the potentiometric principal. An unknown voltage is measured by comparing it to a known adjustable reference voltage with the aid of a null detector. An accurate standard for measurements is obtained by using an internal standard cell to set the reference supply. The known adjustable reference voltage is provided by a 500 volt DC power supply and five Kelvin-Varley decade resistor strings that are set accurately by five voltage readout dials. In this way, the 500 volts can be precisely divided into increments as small as 10 microvolts. The unknown voltage is then simply read from the voltage dials. In the highest null sensitivity range, potential differences between the unknown and the reference voltage of only 0.001 volts will cause full scale meter deflection.

d. The instrument is normally supplied ready for use on 115 volts. Upon request, instruments are supplied for 230 volts operation. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the back of Model 825A or on the rear of the cover in the Model 825AR.

1-2. DAMAGE IN SHIPMENT

Immediately upon receipt, thoroughly inspect for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-3. SPECIFICATIONS (Models 825A and 825AR)

AS A PRECISION POTENTIOMETER

ACCURACY: ±0.025% of input voltage from 0.1 volt to 500 volts. ±0.025% of input voltage plus 25 microvolts, below 0.1 volt.

RANGE:

Input Voltage Range	Recommended Null Range*	Input Resistance per volt of input voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
0-5	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg

*Any null range may be used with any input voltage range; recommended ranges are those most useful.

RESOLUTION: Voltage Readout Dial Resolution

Range Setting	Null Setting	Resolution
500	any	10 mv
50	any	1 mv
5	any	0.1 mv
0.5	any	0.01 mv

Meter Resolution
(1/4 of a small scale meter division)

Range Setting	Null Setting	Resolution
any	10	50 mv
any	1	5 mv
any	0.1	0.5 mv
any	0.01	0.05 mv
any	0.001	0.005 mv

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% on all ranges

RANGE:

Voltage Ranges	Input Resistance
500-0-500	50 Meg
50-0-50	50 Meg
5-0-5	50 Meg
0.5-0-0.5	50 Meg
10-0-10*	10 Meg
1-0-1*	10 Meg
0.1-0-0.1*	10 Meg
0.01-0-0.01*	10 Meg
0.001-0-0.001*	1 Meg

*These range are obtained by using Null ranges with all five voltage readout dials set to 0.

GENERAL SPECIFICATIONS

STABILITY OF REFERENCE SUPPLY:

0.01% for a change in line voltage from 105 to 130 volts.

STABILITY OF METER ZERO:

1% of full scale for a change in line voltage from 105 to 130 volts.

INPUT POWER:

115/230 volts AC (105-130/210-260 volts AC), 50-60 cps, 60 watts.

DIMENSIONS:

Cabinet Model - 13" high, 9-3/4" wide, 14" deep.
Rack Model - 7" high, 19" wide, 14" deep.

WEIGHT:

Cabinet Model - 25 lbs.
Rack Model - 22 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

The location, circuit symbol, and a functional description of external controls, terminals, and indicators on the 825A Precision Differential DC Voltmeter may be found in figure 2-1.

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
Input terminals	Front panel	J1, J3	Provided for connecting DC voltage to be measured.
Chassis ground terminal	Front panel	J2	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input binding post to the chassis ground post. The upper input post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the external circuit should be checked for conflicts in grounding before connecting lower input binding post (middle post) to the chassis post.
Power toggle switch	Front panel	S1	Applies AC line voltage to the primary circuit of the power transformer.
OPERATE-CALIBRATE switch	Front panel	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt DC reference supply. When held in the CALIBRATE position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell, and any difference is indicated on the meter.
CALIBRATE control	Front panel	R2	Varies the output of the 500 volt DC reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the reference supply is accurately set by adjusting the CALIBRATE control for zero meter deflection.
RANGE switch	Front panel	S2	Selects desired voltage range. Full scale voltage ranges of 500, 50, 5, and 0.5 volts are available.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS. (Sheet 1 of 2)

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
NULL switch	Front panel	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Five null voltage ranges of 10, 1, 0.1, 0.01, and 0.001 volts are used for differential measurements. These ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials.
A, B, C, D, and E voltage readout dials	Front panel	S6, S7, S8, S9, S10	Provide an in- line readout of the amount of internal reference voltage necessary to null the unknown voltage.
Decimal lights	Front panel	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different light illuminates for each position of the RANGE switch.
Polarity switch	Front panel	S5	Changes polarity of 825A to match polarity of unknown voltage. With this switch in the positive position, the polarity of the upper input binding post is positive with respect to the lower input binding post (middle post).
Output terminals	Rear panel of 825A, front panel of 825AR	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
Output level control	Rear panel of 825A, front panel of 825AR	R1	Varies the output level of the output binding post from 0 to approximately 23 milliamperes full scale deflection.
Meter	Front panel	M1	Indicates approximate voltage when 825A is in VTVM mode and difference between unknown and internal reference voltage when 825A is in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM. At all other times, the lower scale, 1-0-1, is used.
Mechanical zero control	Meter case	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the meter terminals have been shorted.
Fuse	Rear panel of 825A, front panel of 825AR	F1	Fuse holder protrudes from instrument to provide easy access to the fuse.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS. (Sheet 2 of 2)

2-2. ZEROING INSTRUCTIONS

From time to time, it may be necessary to adjust the internal meter zero control. This will normally be done at somewhat more frequent intervals than complete instrument calibration. Proceed as follows:

a. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the meter terminals prior to zeroing.

b. Set power switch to ON and allow a 20 minute warmup period.

c. Set RANGE switch to 5 or 0.5 volts, voltage readout dials to zero, and NULL switch to 0.001 volt.

d. Adjust R232, VTVM ZERO ADJ, for zero meter deflection. This control may be reached through the ventilation holes in the cabinet model (see figure 4-3). In the rack model, an identified access hole is provided on the rear panel.

2-3. PRELIMINARY OPERATION

The following procedure prepares the voltmeter for operation.

a. Connect power plug to a 115 volt AC power source. If instrument has been wired for 230 volt operation, connect to 230 volts AC.

NOTE

The round pin on polarized three-prong plug connects instrument case to power system ground. Use three-to-two pin adapter supplied with instrument when connecting to a two-contact receptacle. For personnel safety, connect short lead to suitable ground.

b. Set controls on 825A voltmeter as follows:

RANGE	500 volts
NULL	VTVM
polarity	+ (positive)
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least ten minutes, advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE, and adjust internal 500 volt DC reference supply with CALIBRATE control for zero meter deflection. Release OPERATE-CALIBRATE switch.

2-4. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, connect unknown voltage to input binding posts. If one side is grounded, always connect it to the lower input post (middle post).

b. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

c. If meter reads to the left, turn polarity switch to the negative position. The meter needle will deflect to the right. This is because polarity of unknown voltage is negative.

d. Noting the position of illuminated decimal light, set five voltage readout dials to approximate voltage determined in step b. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage readout dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set NULL switch to successively more sensitive null ranges, as indicated in figure 2-2, and adjust voltage readout dials for zero meter deflection in each null position. When the meter needle indicates to the right, the voltage under measurement is greater than the voltage set on the voltage readout dials. When the indication is to the left, the voltage is less than that set on the readout dials.

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING
50-500	10 then 1 (then 0.1 for voltages from 50 to 100 volts)
5-50	1 then 0.1 (then 0.01 for voltages from 5 to 10 volts)
0.5-5	0.1 then 0.01 (then 0.001 for voltages from 0.5 to 1 volt)
0-0.5	0.01 then 0.001

*Any null range may be used with any input voltage range; recommended settings are those most useful.

Figure 2-2. RECOMMENDED NULL SETTINGS

f. Read unknown voltage directly from the five voltage readout dials.

2-5. OPERATION AS A CONVENTIONAL VTVM

If it is desired to use the instrument as a VTVM only, additional ranges can be made available by converting the NULL ranges to VTVM ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:

a. Perform preliminary operation procedures as stated in paragraph 2-3. Connect unknown voltage to input binding posts.

b. Consult figure 2-3, and select full scale voltage deflection desired. If the approximate value of the voltage to be measured is unknown, select the 500 volt range initially.

c. Set RANGE switch, NULL switch, and voltage dials as indicated for the range selected.

d. Connect voltage to be measured to input binding posts. Deflection to the right indicates that unknown DC voltage is of positive polarity.

e. Read voltage from upper or lower scale as listed in figure 2-3.

FULL-SCALE DEFLECTION	RANGE SWITCH	NULL SWITCH	VOLTAGE DIALS	METER SCALE
DC				
500-0-500	500	VTVM	No effect	Upper
50-0-50	50	VTVM	No effect	Upper
5-0-5	5	VTVM	No effect	Upper
0.5-0-0.5	0.5	VTVM	No effect	Upper
10-0-10	No effect	10	All zero	Lower
1-0-1	No effect	1	All zero	Lower
0.1-0-0.1	No effect	0.1	All zero	Lower
0.01-0-0.01	No effect	0.01	All zero	Lower
0.001-0-0.001	No effect	0.001	All zero	Lower

Figure 2-3. VTVM RANGES

2-6. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. Perform preliminary operation as stated in paragraph 2-3.

b. Connect voltage to be observed to input binding posts. If meter reads to the left, the voltage being measured is negative; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.

c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.

d. Set the five voltage readout dials to nominal voltage.

e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.

f. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL voltage setting. Meter deflection to the right indicates that the voltage under observation has increased above the nominal value while deflection to the left indicates it has decreased.

2-7. USE OF 825A WITH A RECORDER

Recorder output binding posts and an output level control are provided on the 825A for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the 825A will be impaired. Also, both input posts of the recorder should be able to stand 500 volts DC to ground. Therefore, the John Fluke Model A-70 Potentiometric Recorder (manufactured by the Texas Instrument Co.) is recommended for this application. Set up the recorder as follows:

a. Connect A-70 recorder to 825A voltmeter with teflon leads as shown in figure 2-4.

NOTE

Do not ground either of the 825A output terminals or either of the A-70 input terminals. If any of these terminals are grounded, current will be drawn from the 825A Kelvin-Varley divider and the accuracy of the 825A will be completely destroyed.

b. After connecting the recorder, perform preliminary operation as stated in paragraph 2-3.

c. Check for excessive leakage as follows:

(1) Connect a voltage to the input of the 825A and differentially measure its potential.

(2) Alternately connect and disconnect the recorder leads from the output terminals of the 825A while noting the meter needle deflection. More than one-quarter of a small scale division deflection indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 825A voltmeter.

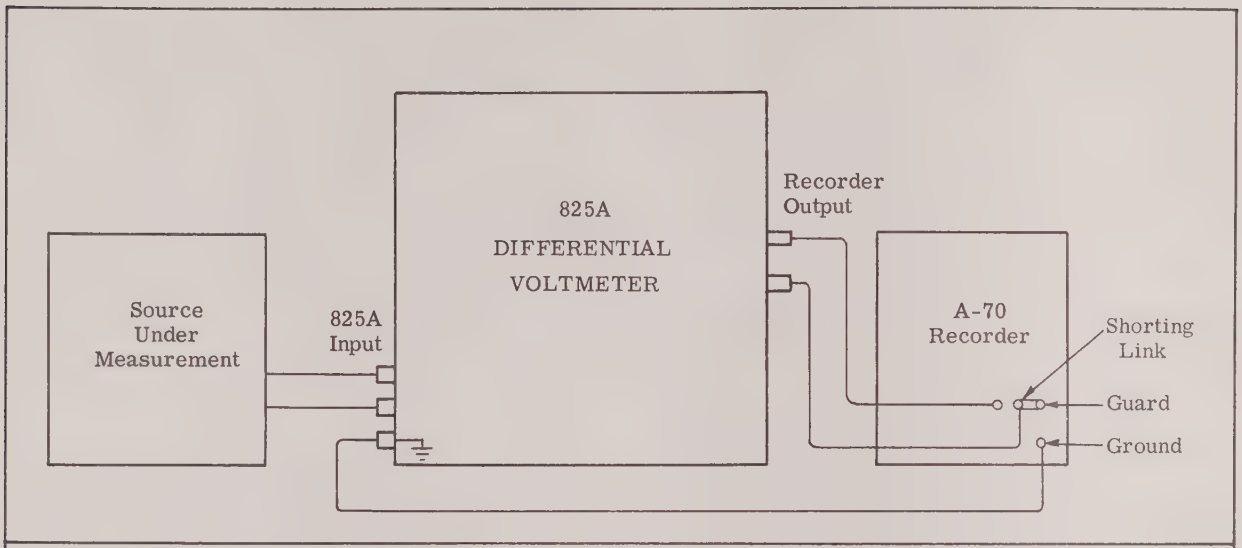
(3) Disconnect the voltage.

d. After the leakage test has been successfully completed, short the input terminals of the 825A.

e. Set switches on the 825A voltmeter as follows:

RANGE	50
NULL	10
voltage readout dials	10.000

The 825A meter will indicate full scale deflection. This provides up to a maximum of approximately 23 millivolts at the output terminals depending on the setting of the output level control.



*If the recorder should be jittery, it is suggested that a 1,000 ohm resistor be substituted for the shorting link.

Figure 2-4. RECOMMENDED CONNECTION DIAGRAM

f. Turn the output level control until the recorder deflection obtained is that desired to correspond to full scale deflection of the 825A.

g. Remove the short from the input terminals of the 825A. The 825A and the recorder are now ready for combined use. Proceed as instructed under paragraph 2-6.

2-8. MEASUREMENT OF HIGH RESISTANCES

One of the important features of the 825A voltmeter is its ability to be used as a megohmmeter for rapidly measuring high resistances from 1 megohm to 500,000 megohms. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts:

$$R_x = 10 \left(\frac{E}{E_m} - 1\right) \text{ megohms,}$$

where:

R_x = unknown resistance in megohms

E = voltage indicated by voltage readout dials

E_m = voltage indicated on meter

10 = megohms of input resistance of VTVM circuit on 10, 1, and 0.1 null range.

When connecting the unknown resistance to the input terminals, use short isolated leads to prevent measuring leakage resistance between the leads.

a. FROM 1 MEGOHM TO 500 MEGOHMS. For rapid measurement of resistances from 1 megohm to 500 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 10.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 10.00 from the amount set on the voltage readout dials to find the resistance of the unknown in megohms.

b. FROM 500 MEGOHMS TO 5000 MEGOHMS. For rapid measurements, of resistances from 500 to 5000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 1.00 from the amount set on the voltage readout dials and multiply the result by 10 to find the resistance of the unknown in megohms.

c. FROM 5,000 MEGOHMS TO 50,000 MEGOHMS. For rapid measurements, of resistances from 5,000 to 50,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Multiply the amount set on the voltage readout dials by 100 to find the resistance of the unknown in megohms.

d. FROM 50,000 MEGOHMS TO 500,000 MEGOHMS. To determine the value of an unknown resistance between 50,000 megohms and 500,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for a convenient meter deflection.

(5) The resistance in megohms may be calculated by substituting the meter reading in volts (Em, 0 to 0.1 volt on bottom scale) and the voltage readout dial setting (E) into the following equation:

$$R_X = 10 \frac{E}{E_m} \text{ megohms}$$

2-9. NOTES ON MEASURING VOLTAGES

a. ADJUSTMENT OF 500 VOLT SUPPLY. The 500 volt DC reference supply may be adjusted (paragraph 2-3, step c) at any time deemed necessary without heed to the position of the switches and without removing any input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to insure that 500 volt reference supply does not shift during the final warmup phase.

b. GROUND LOOP PRECAUTIONS. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 825A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect 825A input binding posts to chassis ground post.

c. RECOMMENDED NULL RANGES. Certain null ranges are recommended for use with each setting of the RANGE switch for the following reasons. With the RANGE switch at 500 volts, the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt if a null is to be obtained on the 0.1, 0.01 or 0.001 volt NULL range. Furthermore, it is unlikely that an unknown voltage of a few hundred volts will be stable within 10 millivolts. Finally, the regulation of the reference supply is approximately 0.005% or ±0.025 volt for a 20% change in line voltage. Although this is more than adequate when the instrument is used in the recommended way, a badly fluctuating line voltage may cause the 825A to meter the regulation of its own 500 volt reference supply. For example, when measuring 500 volts a line change of 20% may cause the 500 volt reference supply to change as much as 25 mv. Although this is small, the 825A will indicate full scale for a change as little as 100 mv, 10 mv, or 1 mv if attempting to use the 0.1, 0.01, or 0.001 null ranges.

d. EFFECT OF AC COMPONENTS. An AC component of several times the unknown DC may be present on the unknown and the 825A will always indicate well within the specifications for frequencies over a few hundred cycles. An AC component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A double section low pass filter (R201, C201, R202, and C202) is used at the input of the null detector to reduce any AC present on the DC being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the AC component is more significant. If this frequency is below 100 cycles, the accuracy may no longer be with specifications. For example, a 60 cycle AC voltage that is 10% of the input voltage will cause an error of approximately 0.01% which is well within the specifications. At low frequencies other than 60 cycles, a larger AC component can be tolerated. Also, since the input attenuation is less for the more sensitive null settings, the accuracy may be effected only on the more sensitive null settings. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 94 cycles), the meter needle will oscillate at the difference frequency. If AC components that affect the accuracy are ever encountered, additional filtering will be required. For an AC of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an AC variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

e. MEASUREMENT OF NEGATIVE VOLTAGES. Because of a polarity switch, voltages which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the upper input post is connected to the metal case, either at the 825A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch, the upper input post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the lower input post (middle post) and use the polarity switch to obtain the proper result.

SECTION III

THEORY OF OPERATION

3-1. GENERAL

a. Figure 3-1 shows the block diagram for the 825A Differential Voltmeter. As seen in this figure, the circuit is mainly composed of an input attenuator, a null detector, a Kelvin-Varley divider, a range divider, a 500 volt DC reference power supply, and a null detector power supply. Refer to the functional schematic following Section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

b. The overall operation of the voltmeter may be summarized as follows. When used as a conventional VTVM, the unknown voltage is connected directly across the input attenuator. This attenuator is set in such a way that the maximum voltage for each range is reduced to a signal of 1 millivolt. The 1 mv signal is applied to the null detector and causes 100 microamperes to flow through the meter for full scale deflection. When used as a differential voltmeter, the unknown voltage is connected across the series combination of the input attenuator and an internal precision DC voltage. This internal voltage is adjusted by means of the Kelvin-Varley divider until it matches the unknown voltage as indicated by the null detector.

c. In order to provide for a more complete understanding of the 825A voltmeter, the following paragraphs describe each section of the circuit in detail.

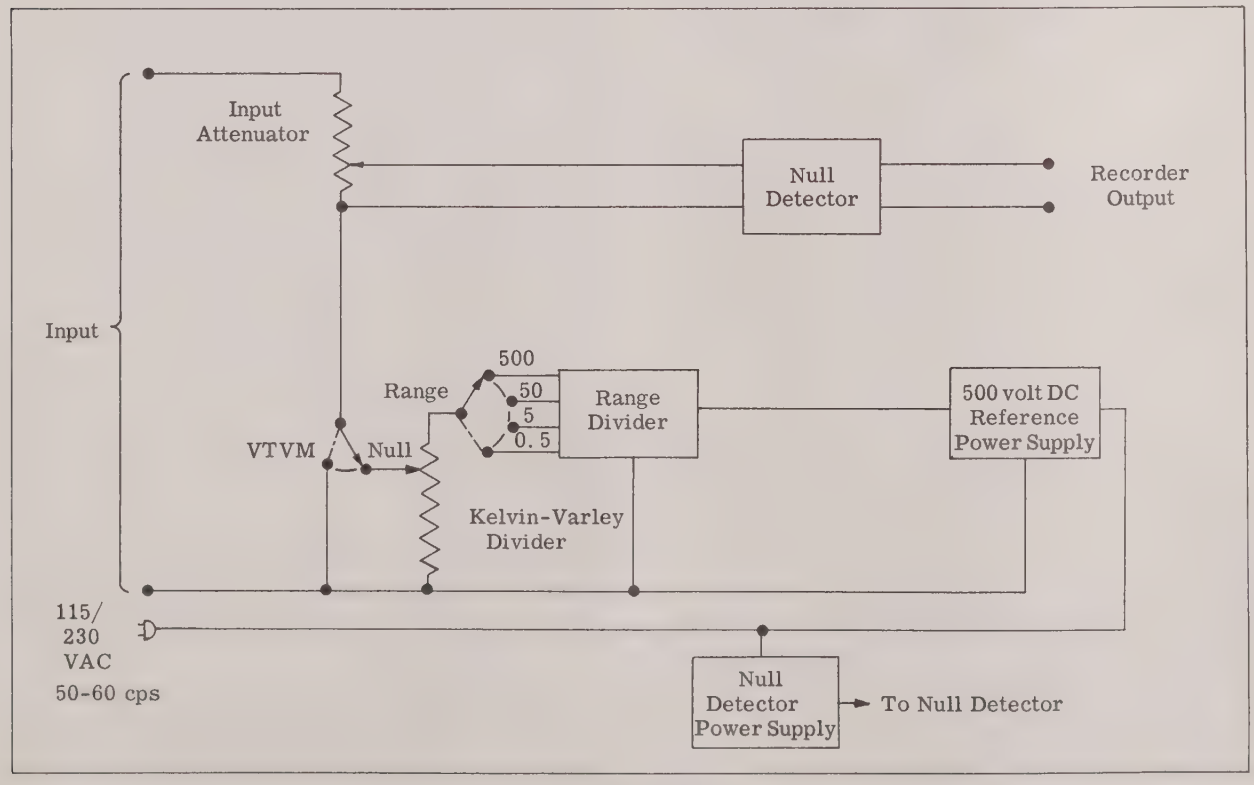


Figure 3-1. 825A DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

3-2. INPUT ATTENUATOR

a. In the VTVM mode, the resistance of the input attenuator and thus the input resistance of the voltmeter is 50 megohms (R301 through R310). For full scale deflection, 1 mv must be applied to the null detector. The necessary reduction is provided by four positions on the input attenuator that are selected by range switch section S2C.

b In the differential mode, the resistance of the input attenuator is 10 megohms (R305 through R310) for the 10, 1, 0.1 and 0.01 null ranges and 1 megohm (R306 through R310) for the 0.001 volt null range. However, this is not the input resistance of the voltmeter. The input resistance is determined by dividing the voltage of the unknown by the amount of current drawn from the unknown. The current drawn from the unknown is equal to the difference in voltage between the unknown and the internally known voltage divided by the resistance of the input attenuator. The equation for input resistance can be hence written as

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|}, \text{ where}$$

R_{in} = input resistance of voltmeter

E_u = voltage of unknown

I_u = current drawn from unknown

R_a = resistance of input attenuator

E = voltage indicated by voltage readout dials

$|\ |$ = absolute value (magnitude only)

Thus, the input resistance is infinite at null.

c. For full scale deflection of 10, 1, 0.1, and 0.01 volts, the voltage difference (unknown voltage minus reference voltage) must be reduced by an attenuator. This reduction is provided by four positions on the input attenuator that are selected by null switch section S3D. On the 0.001 volt null range, the voltage across the input attenuator is fed directly to the null detector.

3-3. NULL DETECTOR

a. GENERAL. The null detector is a fixed gain device containing four resistance-capacitance coupled voltage amplifier stages with a high amount of negative current feedback. With high negative current feedback, the output current is approximately equal to the signal voltage divided by the impedance of the feedback network regardless of the amplifier characteristics or even the load impedance. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual tubes due to aging and replacement. The output current from the null detector is indicated on a meter that has taut-band suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is completely eliminated.

b. OPERATION. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by G1, a 94 cycle chopper. This chopped voltage is amplified by V202A, V202B, and V203A before passing through cathode follower V203B. During half the chopper cycle the output of the amplifier is clamped to approximate null detector common potential by G1 while during the other half the output is filtered by C212 to provide a DC current for the meter. When the chopper provides connection between contacts 1 and 9, a voltage is developed across feedback network R220, R221, and R222 that is proportional to the meter (output) current. This feedback voltage reduces the filter output voltage with respect to the four stage amplifier. The impedance of the feedback network (R220, R221, and R222) is adjustable between 8.82 and 9.83 ohms. Since the output current is approximately equal to the signal voltage divided by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 101.7 to 113.4 ua. However, there is a loss due to finite amplifier gain and filtering that leaves the output current around 100 ua which can be set accurately by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

c. EFFECT OF AC COMPONENTS. The only AC voltage component that will reduce the accuracy of the 825A is one that either saturates the chopper-amplifier or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an AC component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency. The low pass filter at the input of the chopper-amplifier will attenuate any AC component. The magnitude of the AC voltage appearing at the output of the filter depends on both its amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a few hundred cycles. Below this, the filter may not attenuate the AC component enough. However, this is not as bad as it appears. A 60 cycle AC voltage that is 10% of the input voltage will cause an error of approximately 0.01% which is well within specifications. If AC components that affect accuracy are ever encountered, additional filtering as set forth in paragraph 2-9 will eliminate the problem.

d. ADJUSTMENTS. Variable resistor R232 in the null detector power supply provides a means of adjusting the output current of the amplifier to zero when there is no input signal. The gain of the amplifier is adjusted by means of R222 in the feedback circuit.

e. RECORDER OUTPUT. The recorder output is picked off divider string R225, R1, and R226. Output level control R1 provides a means of adjusting the output voltage up to a maximum of approximately 23 millivolts at full scale deflection. The voltage at the output terminals is proportional to the meter reading.

3-4. 500 VDC REFERENCE POWER SUPPLY

a. When the 825A is used for differential voltage measurements, an internal DC voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 500 volt DC reference supply.

b. A half wave rectifier system consisting of three diodes (CR101, CR102, and CR103) and a filter network (R105, R106, C101, and C102) supply unregulated DC voltage to series passing tube V102. The voltage is regulated by comparing the voltage from reference tube V104 with a voltage tapped off a divider string (R119, R120, R121, and R2) in a differential amplifier V105. The output of differential amplifier V105 is fed to differential amplifier V106 which drives the grid of series passing tube V102. In this way the voltage drop across the passing tube is controlled such that the reference supply is maintained at 500 (±0. 025) volts.

c. With RANGE switch set to 500, sections S2B and S2F (just S2F before serial number 185 on 825A and serial number 144 on 825AR) connect 500 volts directly to the Kelvin-Varley divider. In the 50, 5, and 0. 5 volt positions, range resistors controlled by S2E divide the reference voltage to 50, 5, and 0. 5 volts. These voltages are switched to the Kelvin-Varley divider by S2F. The 50, 5, and 0. 5 range resistors networks are set accurately during calibration by means of R323, R326, and R329.

d. Variable resistor R121 is used during calibration to set the reference supply to 500 (±0. 2) volts with CALIBRATE control (R2) set at its center of rotation. This allows the reference supply to be adjusted to 500 (±0. 025) volts by means of the CALIBRATE control at any time deemed necessary. With the OPERATE-CALIBRATE switch held at CALIBRATE, a fixed percentage of the reference supply is compared to the precise potential of the internal standard cell. Any difference in potential is fed to the null detector so that the reference supply can be set with the CALIBRATE control. The fixed percentage of the reference supply is set accurately during calibration by means of R318.

e. For proper operation a highly stable and accurate balance of amplification must be maintained between the two halves of differential amplifier V105. The filament supply for V105 must be regulated to maintain this balance. Regulation is provided by ballest tube V101 which supplies a constant current to the filament of V105. Thus, filament voltage changes, caused by line voltage fluctuations, are absorbed by the ballest tube.

3-5. KELVIN-VARLEY DIVIDER

a. In order to null unknown voltages, each one of the four precision voltages available from the reference supply must be made adjustable. The five Kelvin-Varley decade resistor strings, R401 through R449 accomplish this function.

b. Note that each string, with the exception of the first, parallels two resistors of the string that preceeds it. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the RANGE switch in the 500 volt position, a total voltage of 100 volts DC will appear across these two wipers. Also, there will be 10, 1, and 0. 1 volts DC across the wipers of S7, S8, and S9 respectively. Voltage dial E (S10) picks increments of 0. 01 volts DC from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range.

c. All the resistors of each decade are matched and all decades are matched for each instrument, providing an overall divider accuracy of 0. 005% absolute.

d. With the NULL switch in any null range, the output of the Kelvin-Varley divider is connected in series with the input attenuator as seen from the input terminals. Also, the null detector operates with a common that is above or below (depending on the setting of the polarity switch) the potential of the lower input binding post by the amount set on the voltage readout dials.

3-6. POLARITY SWITCH

Because of the polarity switch S5, upper input post J1 should never be electrically connected to the 825A chassis, either at the 825A or at the source under measurement. As seen in figure 3-2, the polarity switch does not just reverse the input posts. It reverses the

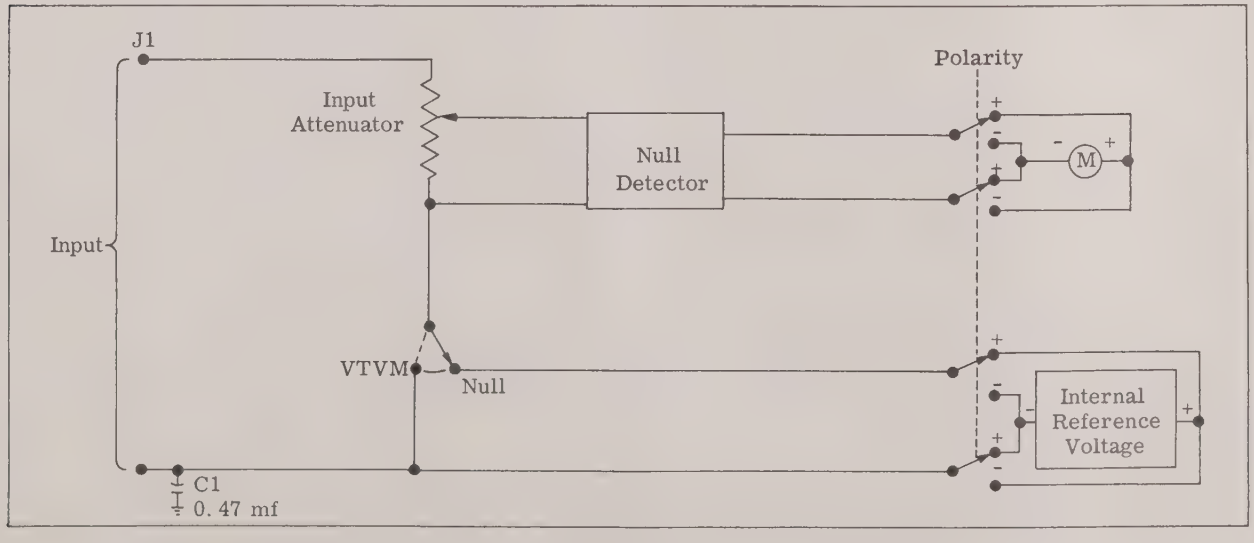


Figure 3-2. FUNCTION OF POLARITY SWITCH

meter and the internal reference supply. If the instrument did not contain a polarity switch, the grounded side of any unknown voltage that is negative with respect to ground would have to be connected to the upper input binding post. This would ground the upper post and effectively place C1 (a 0.47 uf capacitor) across the input terminals. Even if C1 was disconnected, there would still be considerable capacitance across the input due to transformer winding capacitance and stray wiring capacitance. With this capacitance across the circuit being measured several problems would arise. The polarity switch provides equal convenience in measuring positive or negative voltages without the occurance of these problems.

3-7. NULL DETECTOR POWER SUPPLY

a. The B+ supply for the null detector is obtained from a half-wave rectifier consisting of diode CR201 and a filter network (C213A, R227, and C213B) that is regulated by an OA2 tube (V204) and series dropping resistor R230. Divider resistors R228, R229, R231, and R232 and diode CR202 provide a compensating voltage for the purpose of adjusting the null detector to zero with R232 when there is no signal input. Diode CR202 keeps one side of R232 at approximately -0.6 volts DC with respect to the null detector common.

b. The filament of V202 and the chopper drive unit require a stable supply. This is obtained by using a filtered half-wave rectifier (CR203 and C214) that drives a Darlington connection of Q1 and Q2. A divider string R234 and R235 uses the B+ supply to obtain approximately 11.8 volts for pin-5 of V202 while pin-4 is maintained approximately 0 volts through the emitter-base junctions of Q201 and Q202. Any change in the divider string voltage or the half-wave rectifier voltage, is sensed by Q201 and Q202 in such a way that the current flowing through Q202 and hence Q201 changes so that the filament and chopper voltages remain stable. The filament supply for V203 is obtained from an ordinary 6.3 volt AC winding.

SECTION IV

MAINTENANCE

4-1. GENERAL

The 825A Differential DC Voltmeter seldom requires any maintenance. Without extreme abuse, all that should be required is occasional cleaning, tube replacement, and calibration. Preventive maintenance consists only of preventing any leakage as discussed in paragraph 4-2. A discussion of troubleshooting along with a troubleshooting chart, component location diagrams, and a tube voltage chart are provided in paragraph 4-3. Paragraph 4-4 delineates the equipment and procedures necessary to calibrate the instrument.

4-2. PREVENTIVE MAINTENANCE

a. The accuracy of the 825A is adversely affected by excessive electrical leakage from the input of the null detector to either ground or the 500 volt reference supply. This leakage becomes evident when the RANGE switch is set to 500, NULL switch to 0.1, voltage readout dials to 490.00, and no input at the binding posts. The leakage indicated on the meter should be not more than one-tenth of full scale. Special care has been taken to prevent leakage across certain critical switch wafers and areas of some printed circuit boards due to moisture from condensation. The printed circuit boards and sensitive areas of the null detector chassis have been coated with Humi-Seal 1B12 (manufactured by Columbia Technical Corp. of Woodside, N. Y.). The RANGE, NULL, OPERATE-CALIBRATE, and polarity switches have been dipped in Dow Corning silicone oil. Accumulations of dust and foreign matter will cause internal leakage, and should be removed as often as necessary, depending on environmental operating conditions. Blowing the instrument out with low pressure, clean, dry air will remove most accumulations. Particular attention should be paid to the binding posts and wiring, the NULL, RANGE, OPERATE-CALIBRATE, and polarity switches, and the two glass epoxy strips which insulate the null detector chassis from the main chassis.

b. After blowing the instrument out, wipe the glass epoxy strips with a clean dry rag. If necessary use a rag saturated in anhydrous denatured ethyl alcohol. The binding posts, insulators, and front panel may also be cleaned with denatured alcohol. When necessary, the NULL, RANGE, OPERATE-CALIBRATE, and polarity switch may be cleaned with a small, stiff-bristled brush dipped in this alcohol. After washing, recoat the switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

4-3. TROUBLESHOOTING

a. GENERAL. To assist in localizing most troubles which might occur, a troubleshooting chart (figure 4-1) lists the causes and remedies for a number of symptoms. Since failure of the 825A is usually due to tube failure, it is recommended that tube substitution be tried before any other tests are made. However, the 825A is conservatively designed and should require very infrequent tube replacement. At certain times, a check of the DC pin voltages in the tubes (figure 4-5) is also useful. As an aid to troubleshooting, all components may be located by referring to the figures shown in Section V. An understanding of the theory of operation (Section III) and frequent reference to the functional schematic will be of great value in troubleshooting.

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of the 500 volt DC reference supply evidenced by the continual need for resetting with the CALIBRATE control.	V104, V105, or V106 defective.	Check V104, V105, and V106 by replacement.
	One of the sampling string resistors (R119, R120, R121) is changing value rapidly as the instrument warms up.	Locate faulty resistor by heating slightly with a soldering iron held near the resistor while observing the 500 volt DC calibration.
	Drifting standard cell EMF possibly caused by previous shorting or inverting of the cell.	Allow time for the standard cell to stabilize. Several hours should be sufficient.

Figure 4-1. TROUBLESHOOTING (Sheet 1 of 2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Cannot calibrate 500 volt DC reference supply. Meter cannot be brought to zero with CALIBRATE control.	Excessive aging of V104.	Check V104 by replacement.
	Out of calibration.	Recalibrate per paragraph 4-4.
	One or more resistors in 500 volt DC sampling string has shifted in value.	Recalibrate per paragraph 4-4 and observe stability for 48 hours. If 500 volt DC reference supply remains stable replacement of resistor is unnecessary.
	Standard cell EMF has shifted.	Recalibrate instrument and observe stability of reference supply. Replacement of the standard cell may be necessary.
Measurements are out of tolerance on one range other than the 500 volt range.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R325 or R327 has shifted; in 0.5 volt range, R328 or R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on all ranges other than the 500 volt range.	R320 or R321 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on any range when the Kelvin-Varley divider is dialed to any setting other than 499910.	One of the Kelvin-Varley divider resistors is out of tolerance.	Measure the voltage drop across each Kelvin-Varley resistor with another John Fluke Differential Voltmeter. Begin by setting RANGE switch to 500 volts and the voltage readout dials to 499.910. Reference to the schematic diagram will show that there should be 100, 10, 1, 0.1, and 0.01 volts respectively across each resistor of the A, B, C, D, and E decades, except for the two resistors of each decade that are paralleled by the following decade. Across these two resistors, there should be 50, 5, 0.5, and 0.05 volts, respectively. Measure all voltages ±0.05%. Remember that if one resistor in a decade has increased or decreased appreciably, the voltage drop across all other resistors in the decade will be slightly affected also.
Instrument is out of specifications on all ranges.	Resistors R306, R307, R308, R309, or R310 out of tolerance.	Check and replace faulty resistor.
Meter rattle, drift, or error is observed on all null ranges.	V202, V203, or V204 faulty.	Check V202, V203, and V204 by replacement.
	Chopper G1 faulty.	Replace chopper.
	Moisture or dirt on printed circuit boards or switches.	Clean instrument.

Figure 4-1. TROUBLESHOOTING (Sheet 2 of 2)

b. TUBE REPLACEMENT. Replacement of tubes will not normally necessitate complete recalibration of the 825A. If V202 or V203 is replaced, calibrate the null detector as set forth in paragraphs 4-4b and 4-4c. Replacement of V102, V104, V105, or V106 will necessitate calibration of the reference supply per paragraphs 4-4b and 4-4d.

c. COMPONENT REPLACEMENT. Should it ever become necessary to replace a component on a printed circuit board or on the null detector chassis, proceed as follows:

(1) Clean soldered area around component with Methyl Ethyl Keytone.

(2) Remove part and install new component.

(3) Remove flux with DuPont Freon PC.

(4) Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place area under a lamp to ensure thorough drying.

(5) Coat any uncoated areas around R305 through R310 on the Range Resistor Printed Circuit Board and around the input to the null detector chassis (tube V202, 5751, and chopper) with Humi-Seal 1B12.

d. STANDARD CELL PROBLEMS. The standard cell of the 825A deserves special consideration if it is suspected of being faulty:

(1) The standard cell used in the Model 825A is a miniature low hysteresis unit which has excellent long term stability and negligible temperature hysteresis. (Hysteresis is a temporary increase in EMF immediately following a decrease in temperature; this effect should not be confused with temperature coefficient.) Under normal conditions this cell should last from 8 to 15 years. In rare instances, failure has occurred in less than 2 years. End of life is usually marked by an increase in temperature hysteresis effect. That is, reading errors in excess of 0.025% will result when the same voltage is read with the 825A hot and cold. Should replacement of the cell become necessary for any reason, the instrument must be recalibrated (basic 500 volt range only), since the EMF of different cells may be different by as much as 0.05% and each instrument is calibrated to its own particular standard cell. Refer to the recalibration instructions in this case.

(2) Failure of the standard cell may occur if subjected to below freezing temperature. The electrolyte will freeze at 1°F and operation below 32°F is definitely not recommended. The life of the cell also will be greater if the 825A is not operated at elevated temperatures. The 8 to 15 year figure holds for operation of the instrument in normal room temperature.

(3) The EMF of the standard cell will change if the cell has been inverted, or if the cell has been inadvertently short-circuited. If the EMF has changed, the 825A will naturally be out of calibration on all ranges. In either case, the cell will return to its original EMF. If the cell were inverted or shorted for only a few seconds, the 825A should be able to measure voltages within specifications after several hours recovery time.

e. DECIMAL LAMP REPLACEMENT. The decimal lamps are normal 6.3 volt pilot bulbs. To prolong their life these bulbs are operated from a 5 volt transformer winding. However, these bulbs do occasionally fail. To replace, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case.

(2) Remove four screws that hold front panel assembly to chassis.

(3) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(4) Remove screws holding range resistor printed circuit board and Kelvin-Varley printed circuit board to front panel assembly.

(5) Push these printed circuit boards aside enough to allow access to pilot light holders.

(6) Remove pilot light holder from bracket by applying pressure to each side of holder.

(7) Remove cardboard light shield and replace pilot light.

(8) On rack models, remove screws holding cover to instrument and set cover aside.

(9) Remove pilot light holder from bracket by applying pressure to each side of holder.

(10) Remove cardboard light shield and replace pilot light.

4-4. CALIBRATION

a. GENERAL. The 825A can be calibrated as often as deemed necessary. However, it is recommended that the instrument be calibrated every 90 days. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more frequently. Calibration should be accomplished in a draft-free area with ambient temperature of 72 (±3) °F for maximum accuracy under typical laboratory operating conditions. Figure 4-2 lists the type of test equipment required for calibration along with the applicable specifications and recommended instruments. All controls may be located with the aid of figures 4-3 and 4-4. The recommended calibration set-up is shown in figure 4-6. While the Bureau of Standards will certify the Eppley 100 cell to only 0.01%, it may be maintained to 0.002% if treated with care and not subjected to sudden temperature

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
Any Fluke Model 800 series voltmeter. Fluke 301C or 301E Power Supply Eppley Standard Cell 100A Leeds and Northrup 2430A Galvanometer Electro Scientific Industries Special Precision Voltage Divider X194 Any single pole push button switch with fine silver contacts Any double pole push button switch with fine silver contacts Any 5.6 (±10%) Ω resistor Any 56 (±10%) Ω resistor	The equipment used must provide 500, 50, 5, and 0.5 volts with an accuracy of 0.01%.

Figure 4-2. CALIBRATION EQUIPMENT

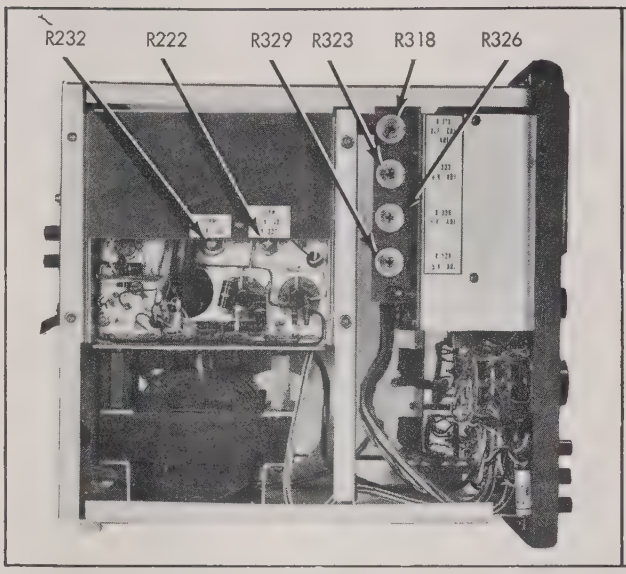


Figure 4-3. ADJUSTMENT LOCATIONS

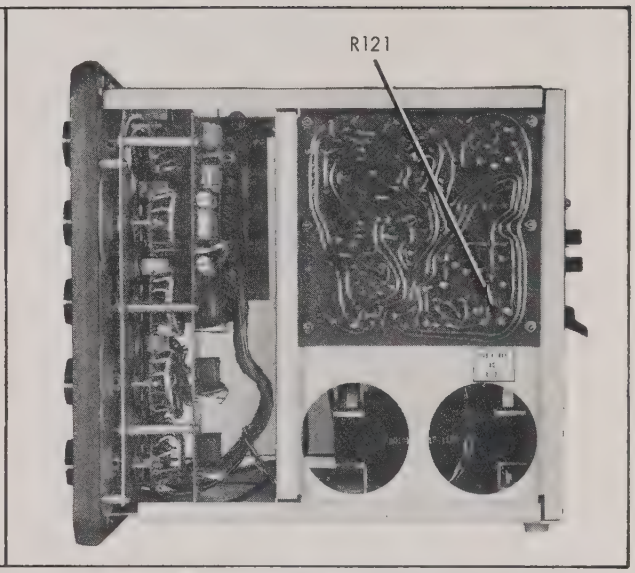


Figure 4-4. ADJUSTMENT LOCATIONS

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V102, 6BQ5	No Conn.	495	500	Heater voltage 6.3 volts ac		No Conn.	680 to 730	No Conn	680 to 730
V104, OG3	85	0	Int. Conn.	0	85	Int. Conn.	0	No Pin	No Pin
V105, 12AX7	217	84	86	Heater voltage 6.3 volts ac		217	84	86	See Pin 4 & 5
V106, 12AX7	495	217	220			500	217	220	
V202, 5751	60	-	0	Heater voltage 12 volts ac		100	-	1.5	No Conn.
V203, 6AW8	47	45	140	Heater voltage 6.3 volts ac		0.7	-	25	50
V204, OA2	150	0	Int. Conn.	0	150	Int. Conn.	0	No Pin	No Pin

This chart is to be used under the following conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM: (c) all voltage readout dials set to zero; (d) line voltage at 115/230 volts, 50 - 60 cycles; and (e) all measurements made with a VTVM from negative binding post to specified terminal.

Figure 4-5. TUBE VOLTAGE CHART

changes. For reasonable certainty of 0.002% cell accuracy, the certified value should be known to six places. Since the ESI voltage divider is accurate within ±0.005%, the overall calibration system accuracy is between 0.003% and 0.007%.

b. PRELIMINARY CALIBRATION PROCEDURES

(1) Set 825A meter to zero with mechanical zero control.

(2) Set switches on 825A as follows:

RANGE	500
NULL	VTVM
polarity	+ (positive)
all voltage readout dials	0 (zero)

(3) Place 825A and all calibration test equipment in operation.

(4) Allow all equipment to warm-up until it reaches equilibrium temperature (about 1/2 hour).

(5) Set up the necessary equipment to provide DC voltages of 500, 50, 5, and 0.5 VDC with an accuracy of at least 0.01%. The recommended equipment and method of connection is shown in figure 4-6.

(6) Set the proper standard cell voltage on the ESI divider.

(7) Apply 500 volts DC into the divider from a ℱ Model 301C or 301E power supply.

(8) Set ESI divider to 500 and zero galvanometer by varying the output of the power supply while depressing the coarse and then the coarse and fine push-button switch. Voltages of 500, 50, 5, and 0.5 volts DC (±0.01%) are made available at the output posts by merely changing the position of the voltage selector switch on the voltage divider.

c. NULL DETECTOR CALIBRATION

(1) Connect chassis ground to line ground.

(2) Short meter terminals and zero meter with adjustment screw on the front of meter case.

(3) Adjust VTVM ZERO ADJ control R233 until 825A meter indicates zero.

(4) Apply 500 volts DC to voltmeter.

(5) Adjust VTVM GAIN ADJ control R222 for full scale deflection.

d. 500 V DC REFERENCE SUPPLY CALIBRATION

(1) Measure reference supply voltage between pin 3 of V102 and negative binding posts.

(2) Center CALIBRATE control at its center of rotation.

(3) Adjust 500 V REF ADJ control R121 until reference supply is 500.0 (±0.2 volts).

e. 500 V DC REFERENCE SUPPLY ADJUSTMENT.

(1) Set switches on 825A as follows:

RANGE	500
NULL	0.1
Voltage read-out dials	499.910

(2) Apply 500 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting CALIBRATE control.

(4) Advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE and null meter by adjusting REF-CAL ADJ control R318.

f. 50 V DC RANGE DIVIDER CALIBRATION.

(1) Set switches on 825A as follows:

RANGE	50
NULL	0.01
Voltage read-out dials	49.9910

(2) Apply 50 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting 50 V ADJ control R323.

g. 5 V DC RANGE DIVIDER CALIBRATION.

(1) Set switches on 825A as follows:

RANGE	5
NULL	0.001
voltage read-out dials	4.99910

(2) Apply 5 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting 5 V ADJ control R326.

h. 0.5 V DC RANGE DIVIDER CALIBRATION.

(1) Set switches on 825A as follows:

RANGE	0.5
NULL	0.001
voltage read-out dials	.49991 0

(2) Apply 0.5 volts DC (±0.01%) to voltmeter.

(3) Null 825A meter by adjusting .5 V ADJ control R329.

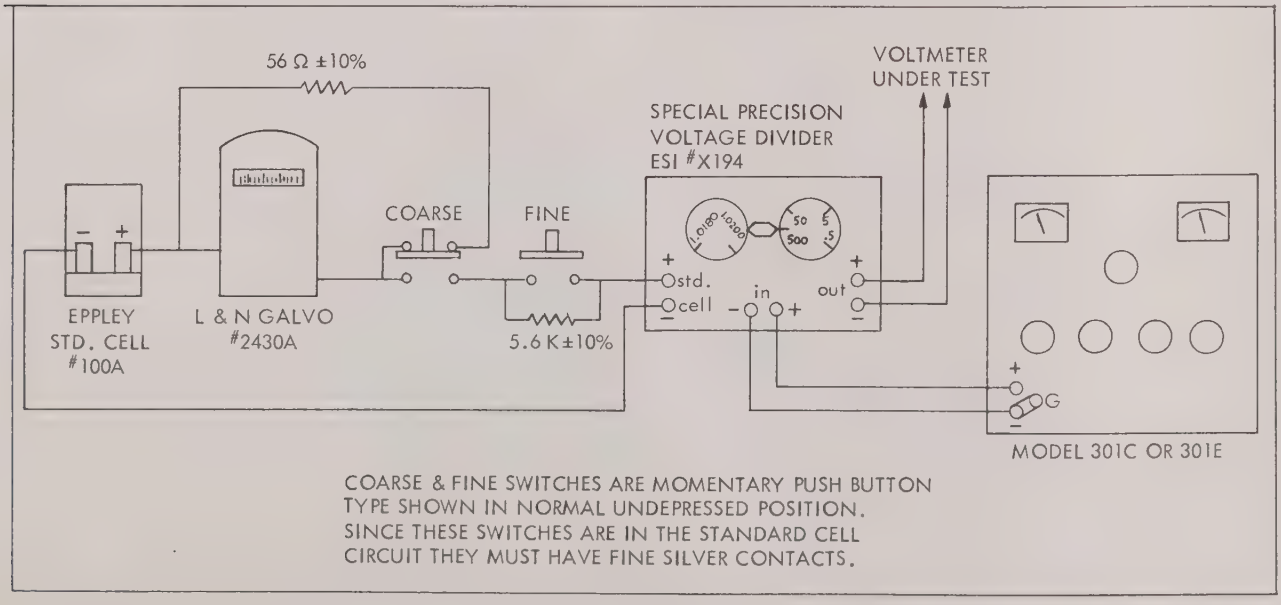

56 Ω ±10%
VOLTMETER UNDER TEST
SPECIAL PRECISION VOLTAGE DIVIDER ESI #X194
COARSE
FINE
EPPLEY STD. CELL #100A
L & N GALVO #2430A
5.6 K±10%
std. cell
in
out
MODEL 301C OR 301E
COARSE & FINE SWITCHES ARE MOMENTARY PUSH BUTTON TYPE SHOWN IN NORMAL UNDEPRESSED POSITION. SINCE THESE SWITCHES ARE IN THE STANDARD CELL CIRCUIT THEY MUST HAVE FINE SILVER CONTACTS.

Figure 4-6. CALIBRATION CONNECTION DIAGRAM

SECTION V

LIST OF REPLACEABLE PARTS

The following six parts lists describe all normally replaceable parts of the Model 825A and Model 825AR RMS Voltmeters. Each list has a corresponding illustration on which the parts for that list are pointed out. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke Stock Number.

A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the 825A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section.

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Final Assembly	825A-501 825AR-502	
	Front Panel Assembly (See figure 5-2)	825A-404 825AR-410	
	Rear Chassis Assembly		
J4, J5	Binding post, black	X219	
	Binding post insulator, red	X217	
C2	Capacitor, electrolytic, 15 uf, -10/+150%, 6V	CE36	
CR1, CR2	Diode, silicon, 300 ma, 400 PIV	2E4	
F1	Fuse, 1 ampere, slow-blowing	F1A	
R1	Potentiometer, wirewound 10 K, 10%, 2W	P10KA	
	Null Detector Chassis Assembly (See figure 5-3)	825A-408	
	Range Resistor Printed Circuit Board Assembly (See figure 5-4)	825A-405 825AR-421	
	Reference Supply Printed Circuit Board Assembly (See figure 5-5)	801B-401	
	Kelvin-Varley Resistor Printed Circuit Board Assembly (See figure 5-6)	801B-403	
T1	Transformer, power	801B-651	

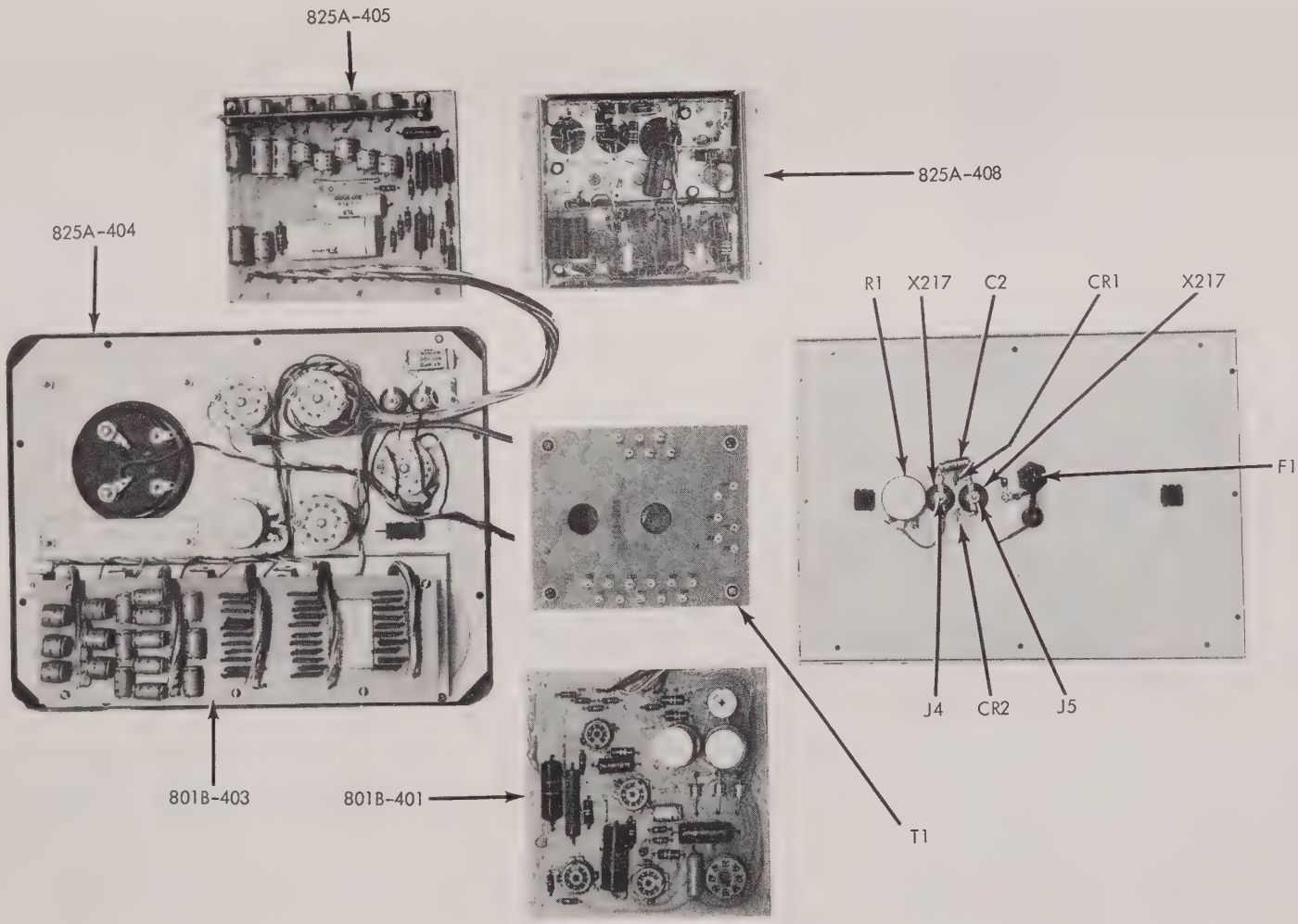


Figure 5-1. FINAL ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Front Panel Assembly	825A-404 825AR-410	
J1, J2, J3	Binding post, black	X219	
	Binding post insulator, red	X217	
	Binding post spacer	X220	
	Knob, 1 inch with pointer	X231	
	Knob, 1-1/2 inch without pointer	X207	
	Knob, 1-1/2 inch with pointer	X234	
	Knob, 1 inch without pointer	X2047	
	Voltage dial plates (cabinet model)	~~D3~~ 2403- 107029	
	Voltage dial plates (rack model)	D2	
B1	Standard cell	X223	
C1	Capacitor, mylar, 0.47 uf, 10%, 600 V	CP25	
M1	Meter, 100-0-100 microamp	M49	
S1	Switch, power	ST5	
S2	Switch, range	801B-804	A
S2	Switch, range	803B-812	B
S3	Switch, null	825A-801	A
S3	Switch, null	825A-812	B
S4	Switch, operate-calibrate	801B-807	A
S4	Switch, operate-calibrate	801B-828	B
S5	Switch, polarity	801B-806	A
S5	Switch, polarity	801B-827	B
S6	Switch, voltage dial A	801B-801	A
S6	Switch, voltage dial A	801B-819	B
S7, S8, S9	Switch, voltage dials B, C, and D	801B-802	A
S7, S8, S9	Switch, voltage dials B, C, and D	801B-820	B
S10	Switch, voltage dial E	801B-803	A

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
S10	Switch. voltage dial E	801B-821	B
DS1, DS2, DS3, DS4	Lamps, decimal	X2051	
R2	Potentiometer, dual section wirewound 1 K and 100 ohm, 10%, 2W	P1KD	

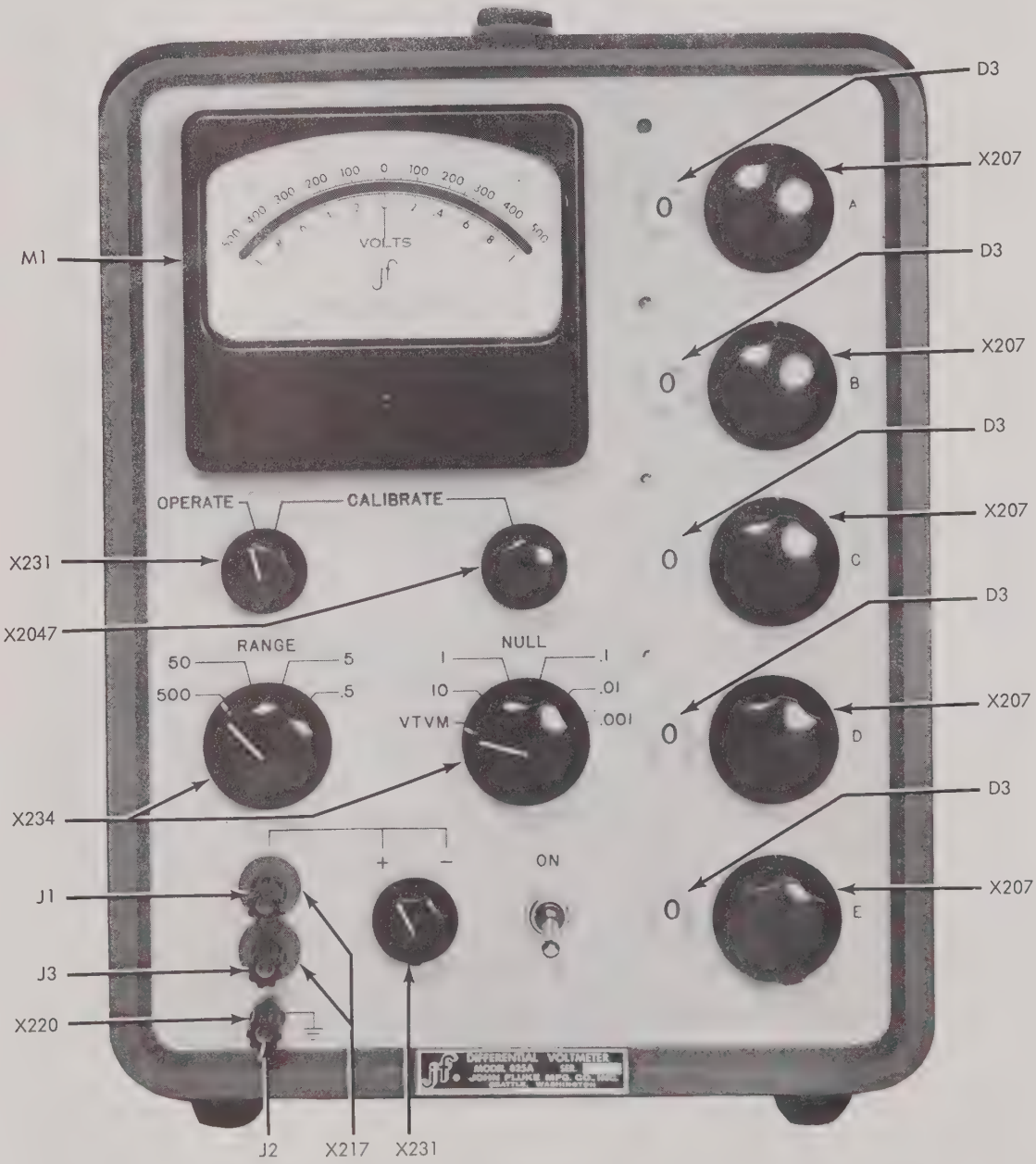


Figure 5-2. FRONT PANEL ASSEMBLY. (Sheet 1 of 2)

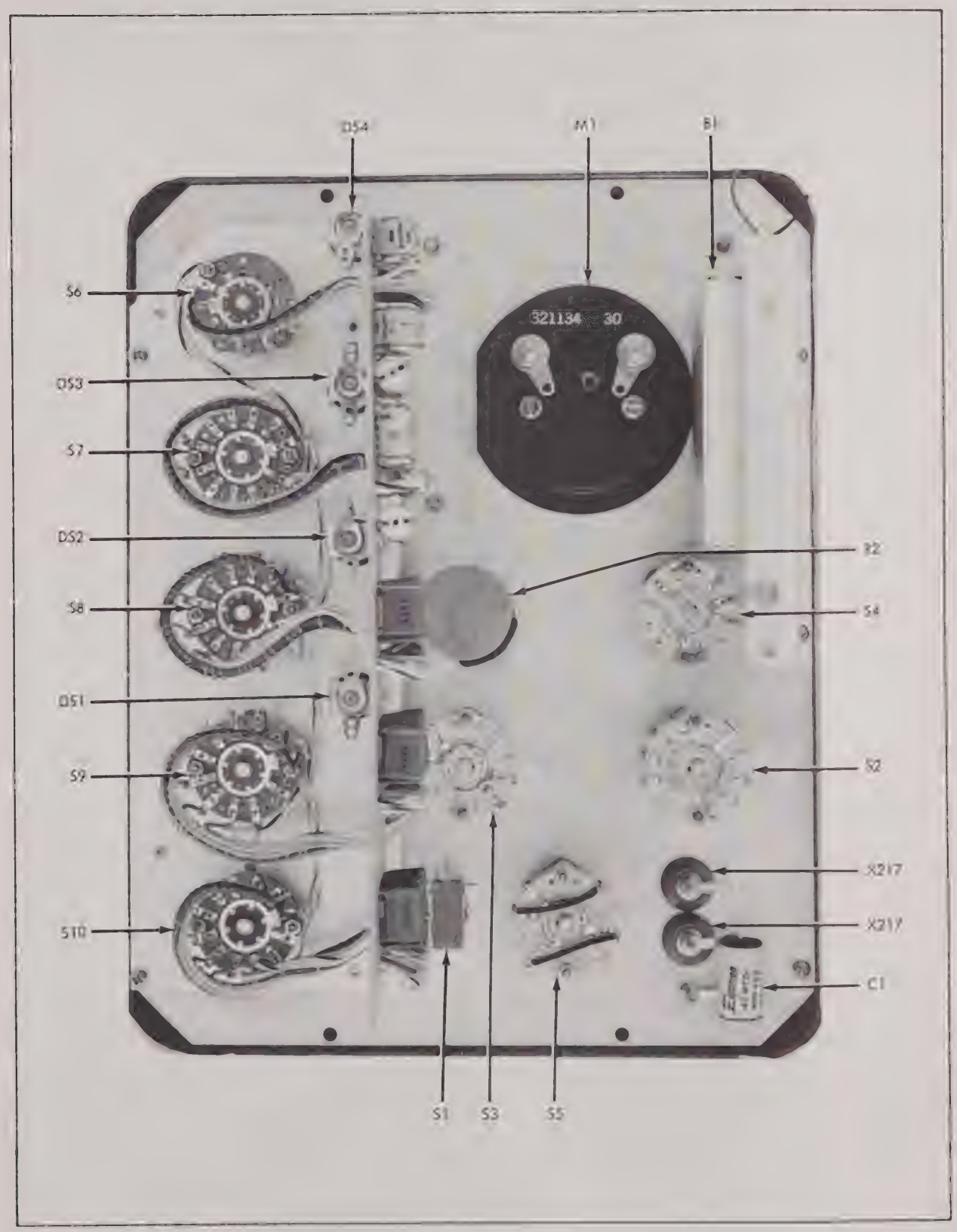


Figure 5-2. FRONT PANEL ASSEMBLY. (Sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Null Detector Assembly without tubes	825A-408	
C201, C202	Capacitor, mylar, 0.1 uf, 20%, 100 V	CF49	
C203	Capacitor, paper, 0.047 uf, 20%, 400 V	CP6G	
C204 ABC	Capacitor, electrolytic, 40-20-20 uf, -10/+100%, 250 V	CE35	
C205	Capacitor, mylar, 0.1 uf, 20%, 200 V	CF46	
C206	Capacitor, electrolytic, 100 uf, -10/+100% 3 V	CE60	
C207	Capacitor, ceramic, 0.005 uf, 20%, 500 V	CT17	
C208	Capacitor, mylar, 0.1 uf, 20%, 200 V	CF46	
C209	Capacitor, mylar, 0.47 uf, 20%, 200 V	CF48	
C210	Capacitor, mylar, 0.1 uf, 20%, 200 V	CF46	
C211	Capacitor, electrolytic, 5 uf, -10/+100%, 50 V	CE75	
C212	Capacitor, electrolytic, 500 uf, -10/+100%, 3 V	CE61	
C213 AB	Capacitor, electrolytic, 20-20 uf, -10/+50%, 450 V	CE5	
C214	Capacitor, electrolytic, 2000 uf, -10/+100%, 25 V	CE25	
C215	Capacitor, electrolytic, 30 uf, -10/+100%, 15 V	CE74	
CR201	Diode, silicon, type IN547, 0.75 Amp, 600 PIV	RE18	
CR202	Diode, silicon, type 2E4, 300 ma, 400 PIV	2E4	
CR203	Diode, silicon, type IN547, 0.75 Amp, 600 PIV	RE18	
G1	Chopper, electronic, 94 cycle, SPDT	X2058	
	Chopper drive unit, 96 cycle	X2059	
Q201	Transistor, germanium PNP, 2N301W	2N301W	
Q202	Transistor, germanium PNP, 2N1372	2N1372	
R201 through R203	Resistor, composition, 820K, 10%, 1/2 W	EB8241	
R204	Resistor, composition, 2.2 Meg, 10%, 1/2 W	EB2251	
R205	Resistor, composition, 22 K, 10%, 1/2 W	EB2231	
R206	Resistor, composition, 150 K, 10%, 1/2 W	EB1541	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R207	Resistor, composition, 4.7K, 10%, 1/2 W	EB4721	
R208	Resistor, composition, 10 Meg, 10%, 1/2 W	EB1061	
R209	Resistor, composition, 10K, 10%, 1/2 W	EB1031	
R210	Resistor, composition, 220K, 10%, 1/2 W	EB2241	
R211, R212	Resistor, composition, 1 Meg, 10%, 1/2 W	EB1051	
R213	Resistor, composition, 180K, 10%, 1/2 W	EB1841	
R214	Resistor, composition, 1K, 10%, 1/2 W	EB1021	
R215	Resistor, composition, 3.3 Meg, 10%, 1/2 W	EB3351	
R216	Resistor, composition, 1.5 Meg, 10%, 1/2 W	EB1551	
R217	Resistor, composition, 4.7K, 10%, 1/2 W	EB4721	
R218	Resistor, composition, 22K, 10%, 1/2 W	EB2231	
R219	Resistor, composition, 220Ω, 10%, 1/2 W	EB2211	
R220	Resistor, deposited carbon, 10Ω, 1%, 1/2 W	DR825	
R221	Resistor, deposited carbon, 75Ω, 1%, 1/2 W	DR23	
R222	Resistor, wirewound, variable, 500Ω, 10% 2 W	P500A	
R223, R224	Resistor, composition, 1.8K, 10%, 1/2 W	EB1821	
R225, R226	Resistor, composition, 47K, 10%, 2 W	HB4731	
R227	Resistor, composition, 2.7K, 10%, 2 W	HB2721	
R228	Resistor, composition, 560K, 10%, 1/2 W	EB5641	
R229	Resistor, composition, 560Ω, 10%, 1/2 W	EB5611	
R230	Resistor, composition, 2.7K, 10%, 2 W	HB2721	
R231	Resistor, composition, 180K, 10%, 1/2 W	EB1841	
R232	Resistor, wirewound, variable, 10K, 20%, 2 W	P10KA	
R233	Resistor, composition, 100K, 10%, 1/2 W	EB1041	
R234	Resistor, deposited carbon, 2.7K, 1%, 1/2 W	DR415	
R235	Resistor, deposited carbon, 31.6K, 1%, 1 W	DR826	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
V201	Lamp, neon glow, type NE2E	X40B	
V202	Vacuum tube, duo triode, 5751	5751	
V203	Vacuum tube, triode-pentode, 6AW8A	6AW8A	
V204	Vacuum tube, voltage reference, OA2	OA2	

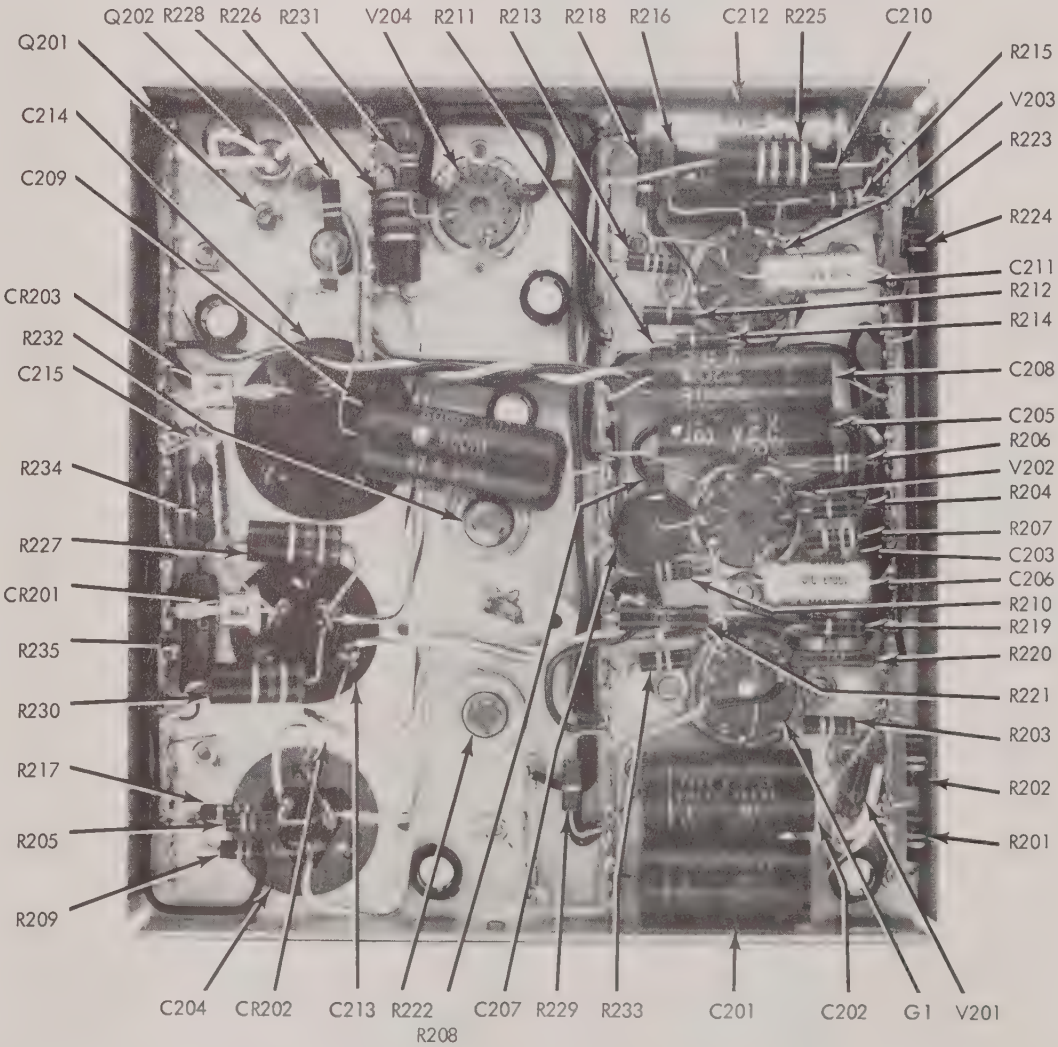


Figure 5-3. NULL DETECTOR CHASSIS ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Range Resistor Printed Circuit Board Assembly	825A-405	
C301	Capacitor, mylar, 1 uf, 20%, 600 V	CP33	
C302	Capacitor, mylar, 2 uf, 20%, 200 V	CF51	
R301 through R304	Resistor, deposited carbon, 10 Meg 1%, 1 W	DR80	
R305	Resistor, deposited carbon, 9 Meg, 1%, 1 W	DR78	
R306	Resistor, deposited carbon, 900 K, 1%, 1/2 W	DR622	
R307	Resistor, deposited carbon, 90 K, 1%, 1/2 W	DR513	
R308	Resistor, deposited carbon, 9 K, 1%, 1/2 W	DR412	
R309	Resistor, deposited carbon, 900Ω, 1% 1/2 W	DR824	
R310	Resistor, deposited carbon, 100Ω, 1%, 1/2 W	DR35	
R311 through R315	Resistor, composition, 22 Meg, 10% 1/2 W	EB2261	
R316, R317	Resistor, wirewound, 125 K, 0.1%, 1 W	PR610	
R318	Resistor, variable, wirewound, 1 K, 20%, 1-1/4 W	P1KM	
R319	Resistor, wirewound, 511.7Ω, 0.1%, 1/2 W	PR643	
R320, R321	Resistor, wirewound, 112.375 K, 0.05%, 1 W	PR615	
R322	Resistor, composition, 27 K, 10%, 1 W	GB2731	
R323	Resistor, variable, 500Ω, 10%, 1-1/4 W	P500M	
R324	Resistor, wirewound, 28.571 K, 0.05%, 1/2 W	PR515	
R325	Resistor, wirewound, 22.5 K, 0.1%, 1/2 W	PR513	
R326	Resistor, variable, 500Ω, 10%, 1-1/4 W	P500M	
R327	Resistor, wirewound, 2531.7Ω, 0.05% 1/2 W	PR49	
R328	Resistor, wirewound, 24.75 K, 0.1%, 1/2 W	PR514	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R329	Resistor, variable, 500Ω, 10%, 1-1/4 W	P500M	
R330	Resistor, wirewound, 250.31Ω, 0.05%, 1/2 W	PR311	
R331	Resistor, composition, 270Ω, 10%, 1/2 W	EB2711	

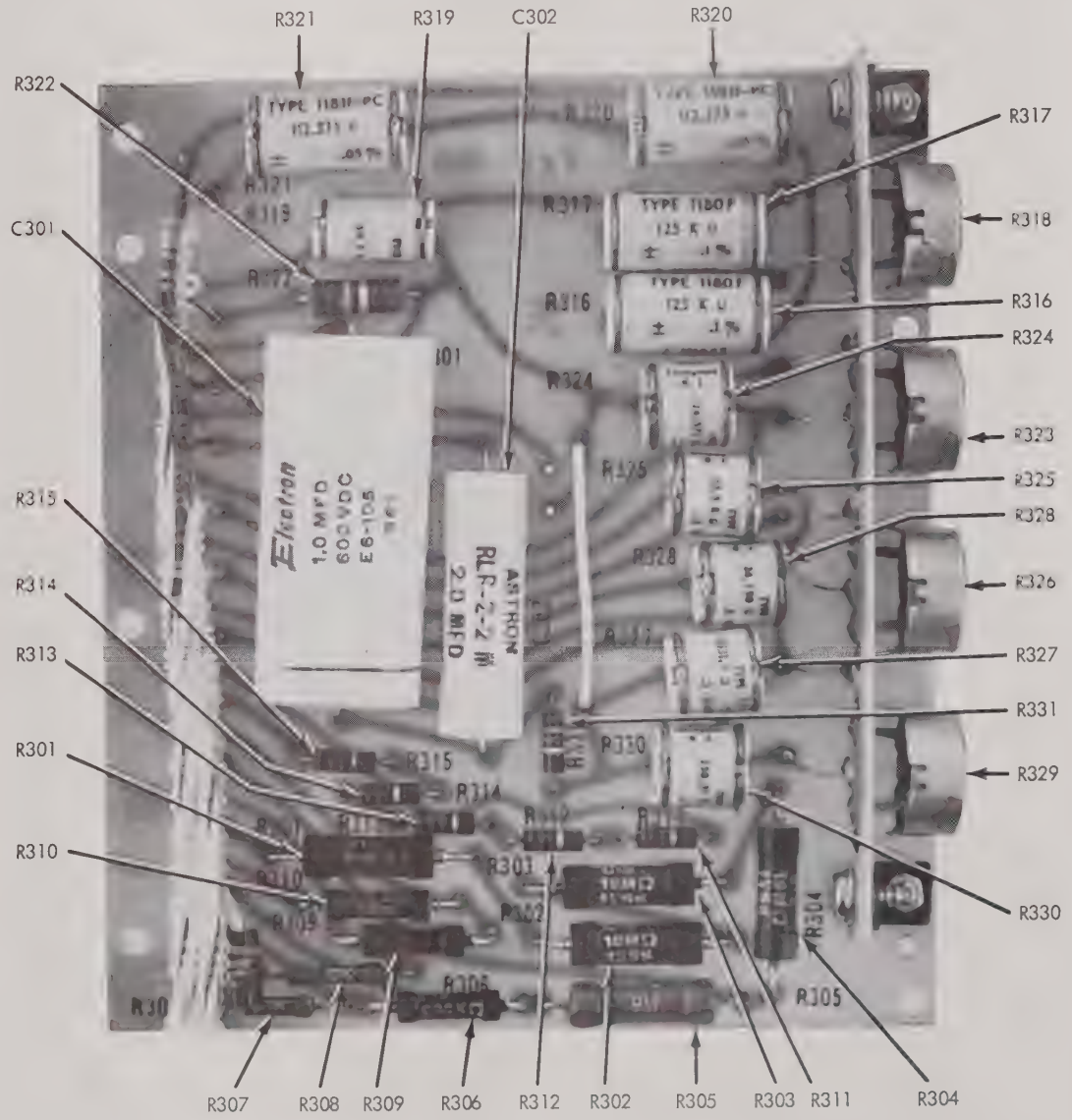


Figure 5-4. RANGE RESISTOR PRINTED CIRCUIT BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Reference Supply Printed Circuit Board Assembly Without tubes	801B-401	
C101, C102	Capacitor, electrolytic, 20 uf, 500 V	CE52	
C103	Capacitor, paper, 0.1 uf, 20%, 400 V	CP4	
C104	Capacitor, mylar, 0.033 uf, 20%, 600 V	CF19	
C105	Capacitor, mylar, 0.1 uf, 20%, 600 V	CF20	
CR101 through CR103	Diode, silicon, 0.750 Amp, 600 PIV	RE18	
R101	Resistor, wirewound, 10Ω, 5%, 10 W	R10WA	
R102, R103	Resistor, composition, 1 Meg, 10%, 1/2 W	EB1051	
R104	Resistor, composition, 220 K, 10%, 1/2 W	EB2241	
R105, R106	Resistor, composition, 270 K, 10%, 1 W	GB2741	
R107	Resistor, composition, 22 Meg, 10%, 1/2 W	EB2261	
R108	Resistor, composition, 15 Meg, 10%, 1/2 W	EB1561	
R109	Resistor, composition, 10 Meg, 10%, 1/2 W	EB1061	
R110	Resistor, composition, 100 K, 10%, 1 W	GB1041	
R111	Resistor, wirewound, 140 K, 3%, 10 W	R140 KW	
R112	Resistor, composition, 100 K, 10%, 1/2 W	EB1041	
R113	Resistor, composition, 560 K, 10%, 1 W	GB5641	
R114	Resistor, composition, 220 K, 10%, 1/2 W	EB2241	
R115	Resistor, composition, 330Ω, 10%, 1/2 W	EB3311	
R116	Resistor, composition, 220 K, 10%, 1 W	GB2241	
R117	Resistor, composition, 82 K, 10%, 1/2 W	EB8231	
R118	Resistor, composition, 560 K, 10%, 1 W	GB5641	
R119	Resistor, wirewound, 386 K, 0.5%, 1 W	PR641	
R120	Resistor, wirewound, 76 K, 0.5%, 1/2 W	PR59	
R121	Resistor, variable, wirewound, 5 K, 20% 1-1/2 W	P5KM	
V101	Vacuum tube, filament regulator, 9-7	9-7	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
V102	Vacuum tube, pentode, EL84/6BQ5	EL84/6BQ5	
V103	Lamp, neon glow, NE2X	X40A	
V104	Vacuum tube, voltage reference, OG3	OG3	
V105	Vacuum tube, duo triode, 12AX7	12AX7	
V106	Vacuum tube, duo triode, 12AX7	12AX7	

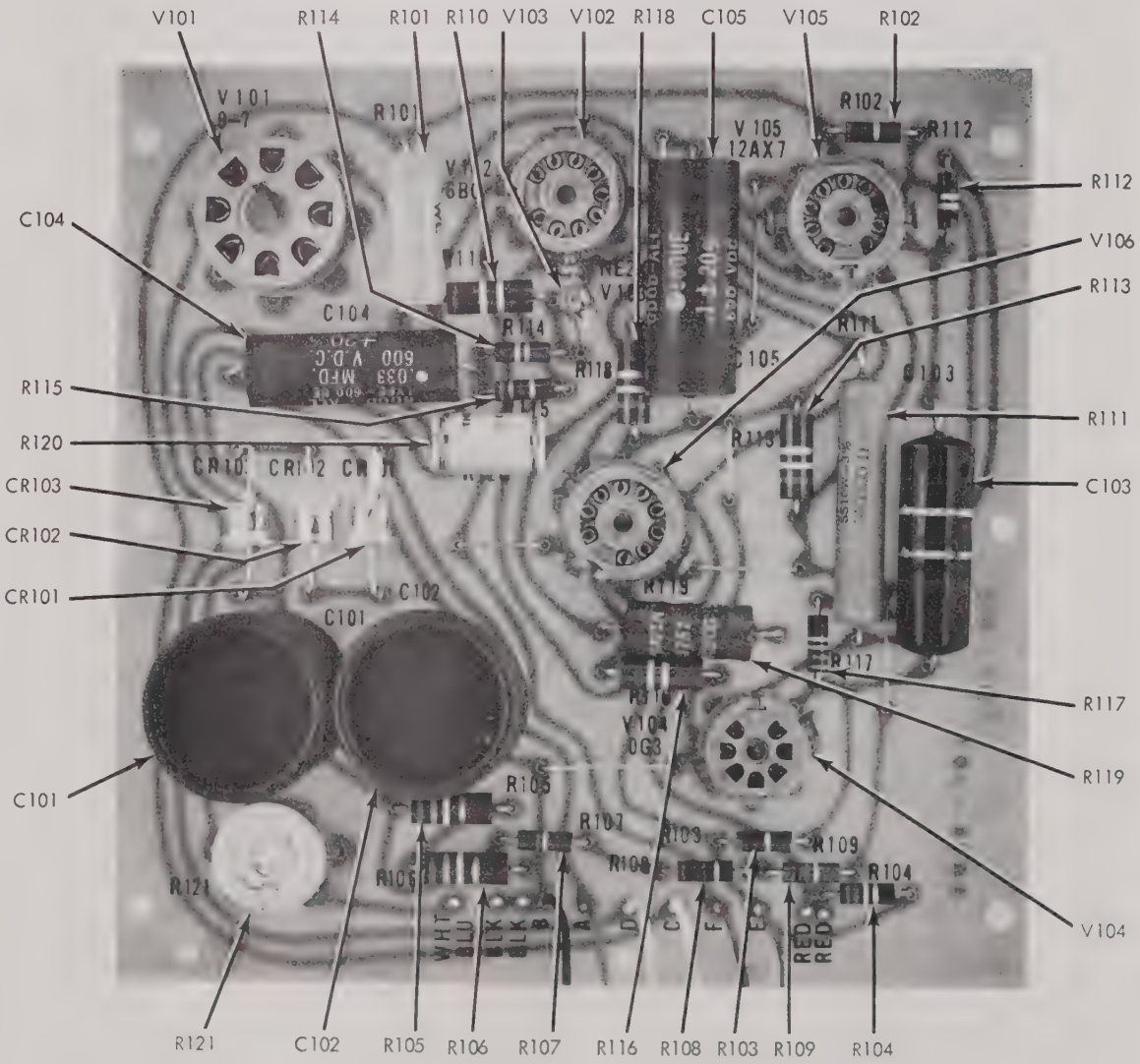


Figure 5-5. REFERENCE SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Kelvin Varley Resistor PCB Assembly	801B-403	
R401 thru R406*	Resistor, wirewound 40 K, 0.02%, 1/2W	PR512	
R407 thru R417*	Resistor, wirewound 8 K, 0.02%, 1/2W	PR48	
R418 thru R428*	Resistor, wirewound 1.6 K, 0.1%, 1/2W	PR46	
R429 thru R439*	Resistor, wirewound 320 Ω, 0.1%, 1/2W	PR39	
R440 thru R449*	Resistor, wirewound 64 Ω, 0.1%, 1/2W	PR24	
	*These resistors are factory matched for each instrument. When ordering, specify instrument serial number.		

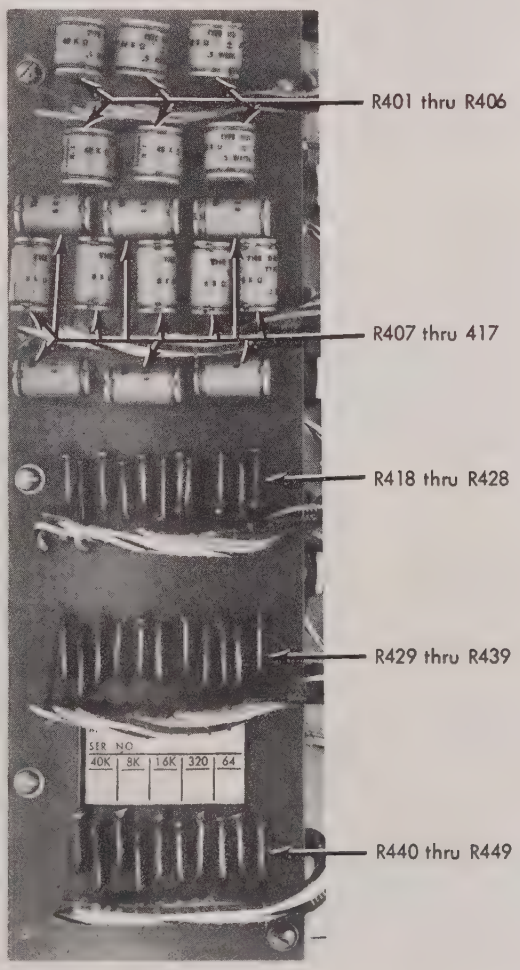


Figure 5-6. KELVIN-VARLEY RESISTOR PRINTED CIRCUIT BOARD ASSEMBLY

USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

USE CODE	EFFECTIVITY
No Code	Model 825A serial number 123 and on Model 825AR serial number 123 and on
A	Model 825A serial number 123 thru 309 Model 825AR serial number 123 thru 213
B	Model 825A serial number 310 and on Model 825AR serial number 214 and on

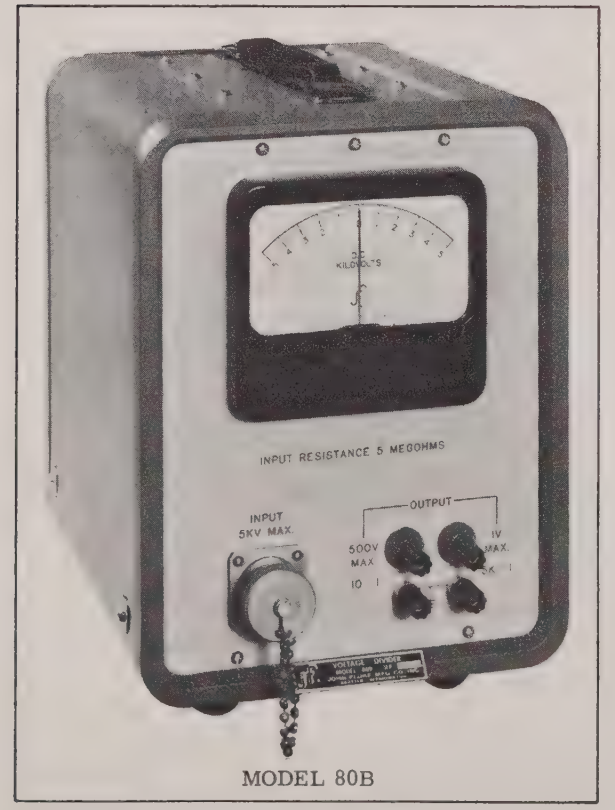
SECTION VI

ACCESSORIES

6-1. PRECISION VOLTAGE DIVIDERS

The Fluke 80A, 80B, and 80C Precision Voltage Dividers provide the ℱ 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30,000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80C dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80B and 80C models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.

MODEL 80A



MODEL 80B

MODEL 80C

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio		Division Accuracy	Stability of Division Accuracy Per Year	Temp. Coef. of Division Ratio
				500 V Out	1 V Out			
80A-1 80A-2	1 KV 2 KV	1 M 2 M	1 ma	2:1 4:1	—— ——	±0.015%	——	——
80B-5 80B-10	5 KV 10 KV	5 M 10 M	1 ma	10:1 20:1	5,000:1 10,000:1	±0.01%	±0.005%	±0.005%/°C from 0°C to 60°C
80C-15 80C-20 80C-25 80C-30	15 KV 20 KV 25 KV 30 KV	15 M 20 M 25 M 30 M	1 ma	30:1 40:1 50:1 60:1	15,000:1 20,000:1 25,000:1 30,000:1	±0.01%	±0.0005%	±0.0002%/°C from 0°C to 35°C

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80B	10-9/32" high 8" wide 10" deep	AN3102-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80C	13" high 9-3/4 " wide 16" deep	Special 5" ceramic standoff with mating 8" polystyrene connector supplied	Insulated binding post on 3/4" centers for both outputs

MODEL A-70 POTENTIOMETRIC RECORDER

6-2. POTENTIOMETRIC RECORDER

The Fluke Model A-70 Self Balancing Potentiometric Recorder is a special purpose high sensitivity recorder developed for monitoring voltages measured by the 800 Series Differential Voltmeters. In addition to providing a permanent record of results, the recorder allows unattended monitoring of various voltages from 0 to 500 volts for long periods of time. A sample voltage which varies in direct proportion to the source under measurement is obtained from the voltmeter null detector by connecting the recorder to the output terminals at the rear of the voltmeter. A gain adjustment control adjacent to the voltmeter output terminals allows the sample voltage to be adjusted such that full-scale meter deflection equals full-scale recorder deflection. The large leakage resistance (500,000 megohms) between the recorder input posts and chassis is such that the inherently high accuracy of the Fluke Differential Voltmeter is generally not impaired in any way.

Electrical Span:	10 mv DC
Span Step Response Time:	Less than 0.5 seconds
Accuracy:	0.5% of span
Chart Speeds:	0.75, 1.5, 3.6, or 12 in./min. or in./hr.
Dimensions:	Cabinet Model - Cabinet Model--9-1/4" high, 8-1/4" wide, 15" deep. Rack Model--Available on special request.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

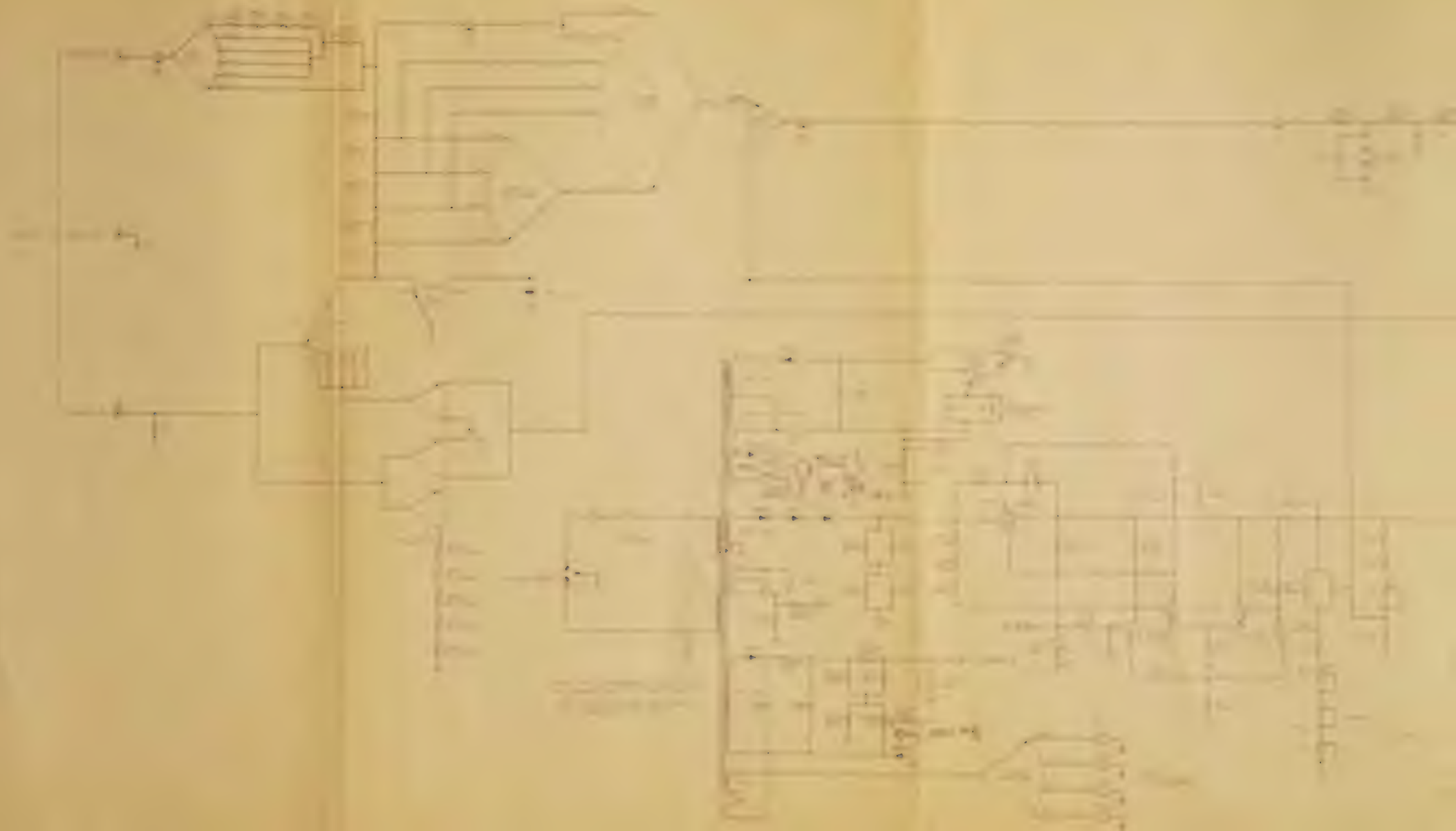
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

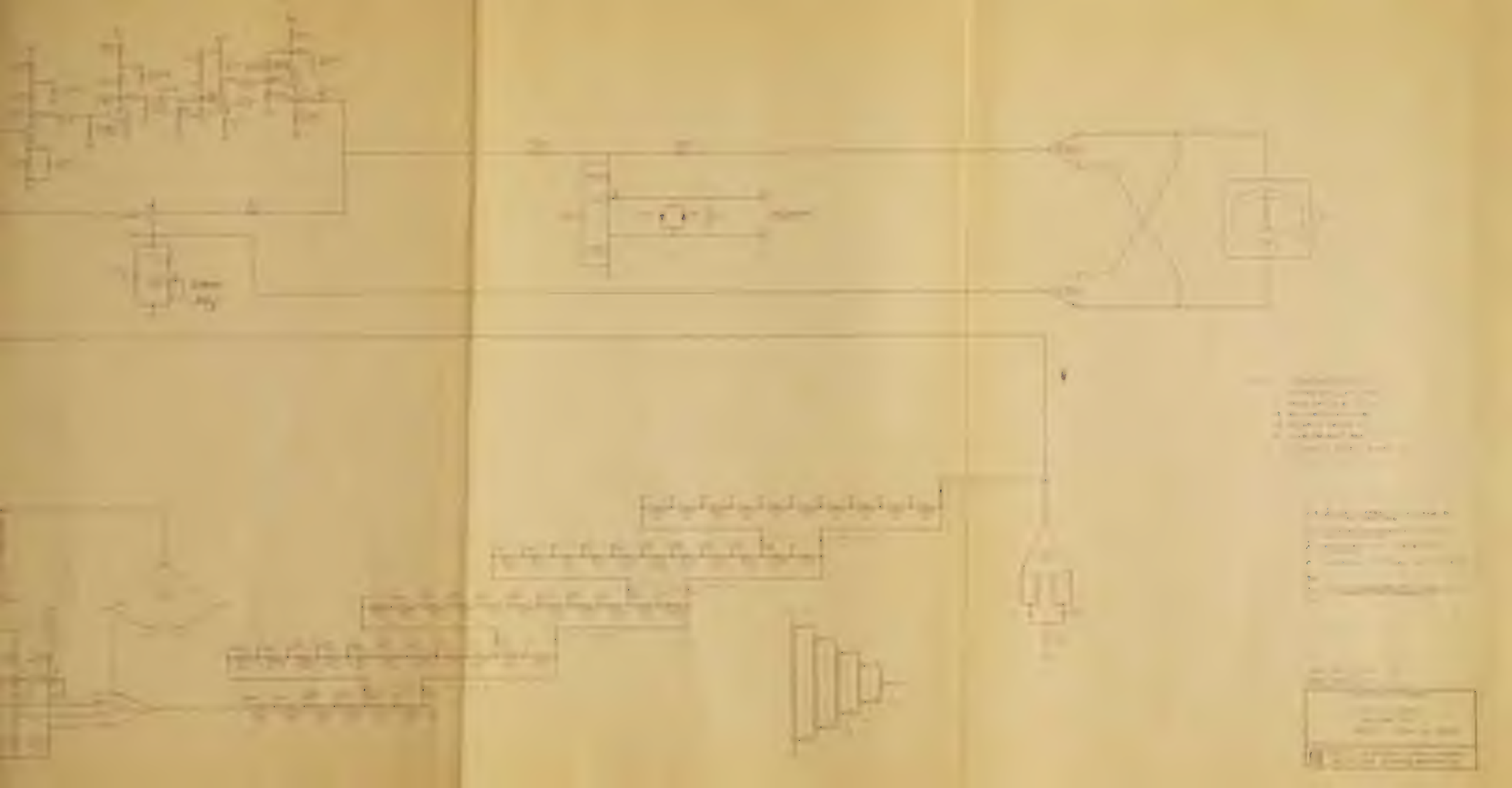
CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON

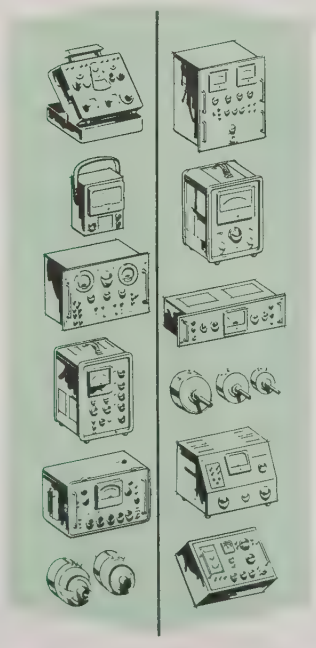




FLUKE

CATALOG F-162

INSTRUMENTS/COMPONENTS



ISSUE NO. 2

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JOHN FLUKE MFG. CO., INC.

P. O. Box 7428 • Seattle 33, Washington

ELECTRONICS FOR INDUSTRY...

Fluke is occupied in research, development, manufacture and design of advanced electronic instruments and components for laboratory and industrial use. Further, Fluke is dedicated to meet the needs of electronics in advancing technology by providing increased capabilities, backed by product-support in accuracy and long life.

JOHN FLUKE MFG. CO., INC.

Located in the Pacific Northwest . . . on the outskirts of Seattle, the Fluke company has grown in a few years from a small engineering firm to its present position as one of the leading manufacturers of precision electronic test and measuring instruments.

The company, which opened with two employees in 1949, moved to Seattle in 1952 where it occupies a new plant of over 34,000 sq. ft. in an industrial park north of the city.

In addition to an expanding line of new voltmeters and power supplies, Fluke has gone into production on a family of vernier and decade precision potentiometers. These new instruments and components are presented in this new short-form catalog for your consideration and evaluation.

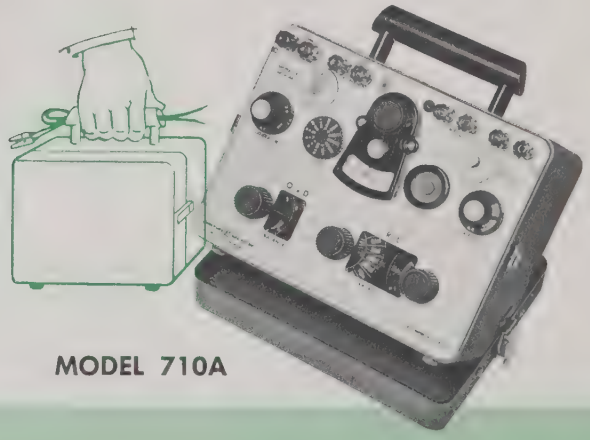
We welcome any inquiries you may make in seeking additional information on these new products or other Fluke instruments now in the line.

UNIVERSAL IMPEDANCE BRIDGE

FEATURES:

- Total weight under 10 lbs.
- Direct in-line readout
- High accuracy
- Wide range
- Plug-in frequency networks

The Model 710A is a compact, versatile, and easy to operate precision bridge. Internal ratio arm resistors and capacitance standard are selected for highest stability, consequently the 710A assures utmost in reliability and long life.



MODEL 710A

SPECIFICATIONS

Resistance:	0-12 megohms in 8 ranges
Accuracy:	±(0.1% + 1 dial division)
Capacitance:	0 to 1200 microfarads in 7 ranges
Accuracy:	± (0.2% + 1 dial division)
Inductance:	0 to 1200 henrys in 7 ranges
Accuracy:	±(0.3% + 1 dial division)
Dissipation Factor (D):	0 to 1.000 at 1 Kilocycle
Accuracy:	±(2% + 0.005)
Storage Factor (Q):	0 to 1000 at 1 Kilocycle
Accuracy:	± (2% + 0.005)

Switches:	All switches use silver alloy contacts
Input Power:	115/230 volts, 50 to 800 cycles, 12 watts
Dimensions:	Cabinet length, 9 inches; width, 7 inches; height, 6½ inches
Price:	$525.00 net F. O. B. factory.
Optional Accessories:	Plug-in RC networks tuned to the following frequencies for use in the detector and generator: 100 cps, 120 cps, 400 cps, 500 cps, 800 cps, 2 KC, 5 KC, 10 KC. Price per pair, $40.00.

DC

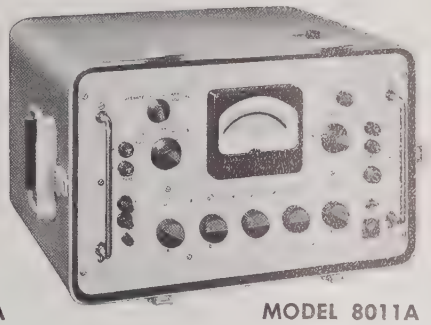
DIFFERENTIAL VOLTMETERS

MODEL 801B

NEW

MODEL 825A

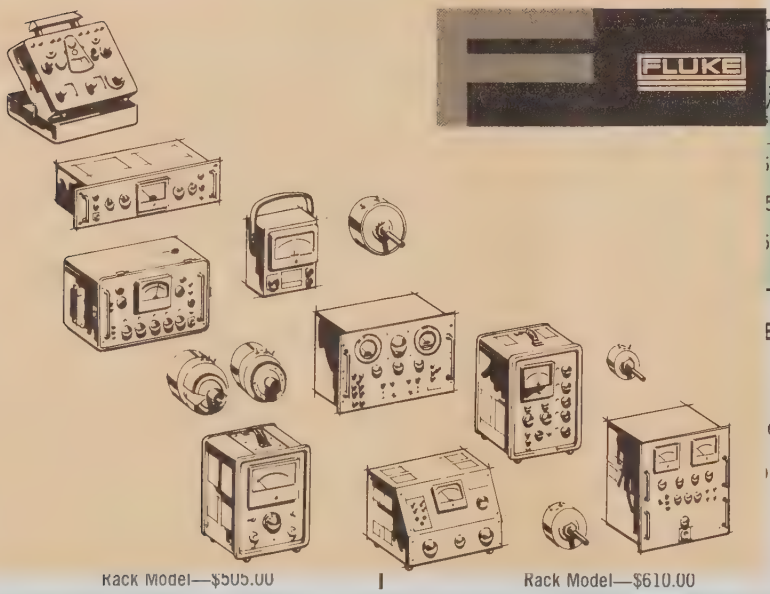
NEW



MODEL 8011A

Fluke now offers a completely new line of DC Differential Voltmeters incorporating the latest in circuit design and manufacturing techniques. Features common to the three new units shown are:

- Infinite input impedance at null from 0-500 V DC (complete freedom from circuit loading error)
- [illegible] readout with automatic lighted decimal
- Recorder output (Models 801B and 825A)
- No zero controls
- Taut band suspension meter (eliminates meter stickiness
- [illegible] glass epoxy printed circuit boards



Maximum Meter Resolution	Reference
50 uv	Std. Cell } Zener Diode
5 uv	Std. Cell } Optional
50 uv	Temp. controlled Zener diode

Rack Model—$505.00

Rack Model—$610.00

MILITARIZED DC DIFFERENTIAL VOLTMETER

MODEL 8011A

DIMENSIONS: Combination case with cover—19" wide x 11½" high x 19½" long

WEIGHT: 57 pounds

PRICE: $1,745.00

PRECISION VOLTAGE DIVIDERS

Designed for use with the Fluke Model 800 Series Differential Voltmeter, Fluke precision voltage dividers provide high accuracy measurements to 30,000 V DC. All units have zero center panel meters to indicate polarity and approximate magnitude of unknown high voltage. All models draw 1 ma current at maximum input.

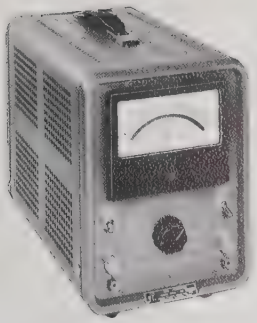
MODEL 80A

MODEL 80C

Model No.	Maximum Input Voltage	Total Resistance	Division Ratio 500 V Out	Division Ratio 1V Out	Division Ratio Accuracy	Price
80A-1	1 KV	1M	2:1	—	±0.015%	$ 100.00
80A-2	2 KV	2M	4:1	—	±0.015%	110.00
80B-5	5 KV	5M	10:1	5,000:1	±0.01%	225.00
80B-10	10 KV	10M	20:1	10,000:1	±0.01%	350.00
80C-15	15 KV	15M	30:1	15,000:1	±0.01%	720.00
80C-20	20 KV	20M	40:1	20,000:1	±0.01%	845.00
80C-25	25 KV	25M	50:1	25,000:1	±0.01%	970.00
80C-30	30 KV	30M	60:1	30,000:1	±0.01%	1,095.00

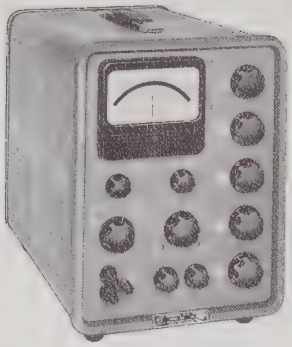
AC VOLTAGE MEASURING INSTRUMENTS—SEE NEXT PAGE

AC VOLTAGE MEASURING INSTRUMENTS



NEW

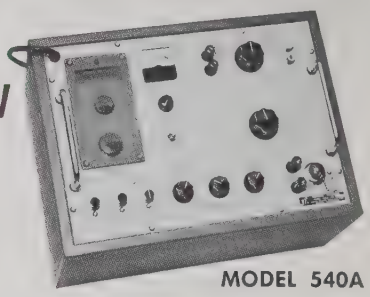
MODEL 910A



PRECISION AC VOLTMETERS

NEW

MODEL 803



MODEL 540A

Three of the most well accepted and proven methods for obtaining highly accurate AC voltage measurements have been incorporated by Fluke to supply industry and the military with instruments well suited to cover a broad range of sensitivity, bandwidth and accuracy requirements. The electronics engineer may now select either the Model 910A Broadband True RMS voltmeter with panel meter readout for 1% accuracy, the Model 803 differential voltmeter with in-line 5-dial readout for 0.2% accuracy or the Model 540A Thermal Transfer Standard with Galvanometer readout for 0.02% accuracy.

Unique simplified design in each instrument provides the user with ease of operation plus long term trouble free operation for maximum dollar value at minimum cost.

TRUE RMS VOLTMETER

The Fluke Model 910A True RMS Voltmeter is a new basic instrument which combines true RMS response with 1.0% accuracy over a broad frequency range. Its true RMS response, by definition, guarantees that the accuracy of the indicated reading, of virtually any waveform, is maintained regardless of its amplitude characteristics.

MODEL 910A

SPECIFICATIONS

Voltage Range: 100 uv to 300 v in twelve ranges

Decibel Range: −72 to +52 dbm in twelve ranges

Frequency Response: 10 CPS to 7 MC

Accuracy: ±1% of full scale 50 CPS to 800 KC
±2% of full scale 20 CPS to 2 MC
±3% of full scale 20 CPS to 3.5 MC
±5% of full scale 10 CPS to 7.0 MC

Crest Factor: Three at full scale. Proportionately higher for readings of less than full scale

Input Impedance: 10 megohms shunted by 30 uuf on ranges from 0.001 v to 0.300 v
10 megohms shunted by 15 uuf on ranges from 1.0 to 300 v

Amplifier: Output terminals provide approximately 100 mv RMS at full scale regardless of range

Dimensions: Cabinet Model—7¼" wide x 10½" high x 15" deep
Rack Model—19" wide x 5¼" high x 13¼" deep

Price: Cabinet Model—$545.00
Rack Model—$565.00

AC/DC DIFFERENTIAL VOLTMETER

The Fluke Model 803 Differential Voltmeter, employing the differential measurement technique, provides versatility in measuring either AC or DC to high orders of accuracy.

MODEL 803

SPECIFICATIONS

Voltage Range: DC—0-500 volts
AC—0.05-500 volts

Accuracy: DC—±0.05% of input voltage from 0.1-500 v. ±0.1% of input voltage or 50 uv, whichever is greater from 0 to 0.1 v
AC—±0.2% of input voltage from 0.5-500 v over 30 CPS to 10 KC frequency range. Reduced accuracy from 0.05-0.5 v

Input Impedance: DC Infinite at null. AC—1 megohms shunted by approx. 25 uufd

Reference: Standard cell, zener reference optional at additional cost

Dimensions: Cabinet Model—9¾" wide x 13" high x 16" deep
Rack Model—19" wide x 8¾" high x 17-5/16" deep

Weight: Cabinet Model—30 pounds
Rack Model—38 pounds

Price: Cabinet Model—$875.00
Rack Model—895.00

AC/DC THERMAL TRANSFER STANDARD

The Fluke Model 540A Thermal Transfer Standard provides extreme accuracy for applications requiring measurement capability equal to the limits of accuracy certified by the National Bureau of Standards.

MODEL 540A

SPECIFICATIONS

Voltage Ranges: 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000 volts

Transfer Accuracy:

Range	Frequency	AC/DC Difference
0.5 v	5 cps–100 kc	±0.02%
	5 cps -500 kc	±0.05%
1v-10 v	5 cps -500 kc	±0.02%
20v-50 v	5 cps–100 kc	±0.02%
	5 cps–500 kc	±0.2 %
100v-500 v	5 cps–50 kc	±0.03%
1000 v	5 cps–20 kc	±0.05%

Calibration: Traceable to NBS certification to 50 KC

Transfer Input Impedance: 200 ohms/volt

Galvanometer: Built-in reflecting type; binding posts and switch provided for external galvanometer

Galvanometer Resolution: 0.02%/ millimeter at nominal range voltage

Search Meter: This circuit is provided to select the proper voltage range thereby minimizing the possibility of thermocouple overload

Dimensions: 10¾" wide x 8½" high x 14½" long

Weight: 11½ pounds

Price: $795.00

We invite you to write for information on new Fluke Model A55 thermal converters to extend the range of model 540A to 50 MC.

POWER SUPPLIES

Field tested and proven in the fields of production testing, general laboratory development and nuclear research, the Fluke line of power supplies are widely accepted as reliable standards. Ranging in output from 0 to 10 Kilovolts and 0 to 500 milliamperes, these units provide the user with the needed high orders of stability, regulation and calibration accuracy for virtually every application.

These are a few of the applications where Fluke power supplies can best assist you: • DC instrument calibration • power traveling wave tubes where R. F. phase jitter must be minimized • power Klystron tubes when frequency stability is essential • power source for pulse transmitters • nuclear research applications where high stability and low ripple are important • charging capacitor banks for high voltage work • other laboratory and industrial applications requiring accuracy and dependability.

GENERAL PURPOSE-DC LABORATORY POWER SUPPLIES:

Suggested applications: Circuit development, production checkout, meter calibration, and general laboratory applications.

*Model 406 also available as rack mounted model 406R
8¾″ high x 19″ wide x 16¾″ deep
Weight—41 lbs. Price—$305.00

**Model 407D also available as rack mounted model 407DR
19″ wide x 8¾″ high x 16¾″ deep
Weight—48 lbs. Price—$355.00

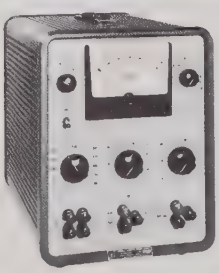
MODEL	VOLTAGE	CURRENT	REGULATION LINE	REGULATION LOAD	STABILITY PER HOUR	STABILITY PER DAY	CALIBRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
*406	0-530 v	0-100 ma	0.01%	0.01%	0.01%	0.05%	—	1 mv	2 mv	$ 285.00
**407D	0-555 v	0-300 ma	0.005%	0.01%	0.01%	0.05%	0.5%	500 uv	2 mv	335.00
PRECISION CALIBRATORS										
301E	1.02-512 v	0-300 ma	0.005%	0.005%	0.005%	0.01%	0.1%	2 mv	500 uv	695.00
301C	1.02-1012 v	0-400 ma	0.005%	0.005%	0.005%	0.01%	0.1%	2 mv	500 uv	985.00
334B	0-3111 v	0-400 ma	0.002%	0.005%	0.005%	0.01%	0.03%	1 mv	50 uv	2,650.00

CONSTANT CURRENT POWER SUPPLY:

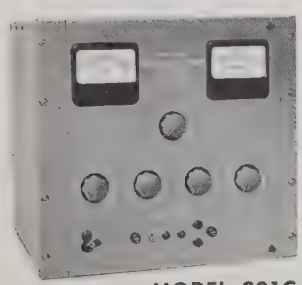
Featuring 0.1 microamp resolution coupled with high calibration accuracy and excellent long term stability, Model 351A is particularly useful for calibration and testing of instruments, microammeters and milliammeters, etc.

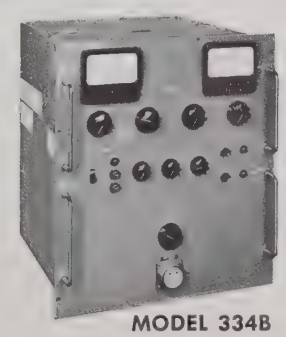
MODEL	VOLTAGE	CURRENT	REGULATION LINE	REGULATION LOAD	STABILITY PER HOUR	STABILITY PER DAY	CALIBRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
351A	0-100 v	1 ua-100 ma	0.01%	0.01%	0.005%	0.01%	0.05%	0.05%	0.1 ua	$845.00

MODEL 406

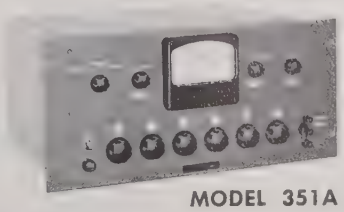

MODEL 407D

MODEL 301E


MODEL 301C


MODEL 334B

NEW


MODEL 351A

POWER SUPPLIES—CONTINUED NEXT PAGE

POWER SUPPLIES

HIGH VOLTAGE POWER SUPPLIES

Suggested applications: Power photomultiplier tubes and ionization chambers . . . for research and development of traveling wave tubes and backward wave oscillators . . .

MODEL	VOLTAGE	CURRENT	REGULATION LINE	REGULATION LOAD	STABILITY PER HOUR	STABILITY PER DAY	CALIBRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
409A	170-1530 v	0-3 ma	0.01%	0.4%	—	0.02%	—	0.002%	85 v steps	$ 335.00
412A	500-2010 v	0-15 ma	0.01%	0.01%	0.005%	0.03%	0.25%	5 mv	10 mv	455.00
413A	0-3111 v	0-20 ma	0.001%	0.001%	0.005%	0.03%	0.25%	150 uv	1.5 mv	695.00
405	600-3100 v	0-15 ma	0.01%	0.005%	0.005%	0.05%	0.5%	5 mv	10 mv	595.00
408A	500-6010 v	0-20 ma	0.01%	0.01%	0.005%	0.03%	0.25%	5 mv	10 mv	695.00
410A	1000-10,010 v	0-10 ma	0.01%	0.01%	0.005%	0.05%	0.25%	5 mv	10 mv	1,095.00

MODEL 409A

MODEL 413A

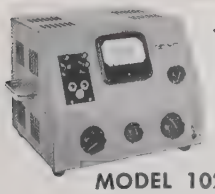
MODEL 412A

MODEL 405

MODEL 408A

MODEL 410A

VAW METER



MODEL 102

. . . measure Volts, Amps, Watts

The jf Model 102 VAW Meter has a maximum true power sensitivity of 225 microwatts and will measure up to 18 kilowatts over the frequency range of 20 CPS to 100 KC. With a one megohm input resistance and a shunt drop of only 45 millivolts full scale, the Model 102 generally produces negligible insertion loss effects on the circuit under test. The VAW Meter is ideally suited to measuring true power consumed by a wide variety of loads including both linear and nonlinear elements such as servo components, transformers, rectifiers and substantially any power-consuming circuit configuration.

SPECIFICATIONS

Voltage full scale: 1.5–600 v
Current full scale: 1.5 ma–30 Amps.
Power: 225 uw to 18 KW

PRICES

Cabinet model—**535.00**
Rack model—**585.00**
Current shunts—**$20.00** ea.

Power Factor Range	Frequency Response	Accuracy	Input Impedance
1.0	20 CPS—100 KC	3%	1 megohm
0.1	20 CPS— 20 KC	3%	25 uufd
0.1	20 KC — 40 KC	5%	———

RECORDER

MODEL A-70

Monitoring of voltages measuring by the Fluke 800 series differential voltmeters is readily possible using the Model A-70 Potentiometric Recorder. All standard 800 series voltmeters are provided with recorder output terminals to facilitate use of this convenient accessory.

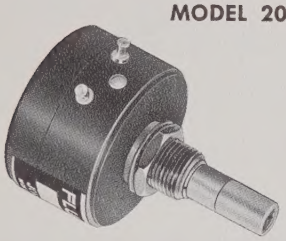
ELECTRICAL SPAN:	10 MV DC
SPAN STEP RESPONSE TIME:	0.5 seconds or less
RATIO ACCURACY:	0.5% of span plus 10 uv
CHART SPEEDS:	0.75, 1.5, 3, 6, or 12 in./min. or in./hr.
PRICE:	$745.00

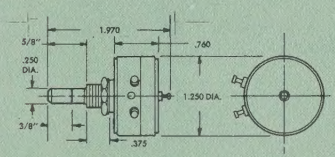
PRECISION POTENTIOMETERS

The John Fluke Vernier Potentiometers combine the advantages of high resolution, linearity and AC response in a small case at moderate prices. All models of the 20 series provide resolution better than conventional ten-turn potentiometers in less than 1½ turns. Resistance ranges from 100 ohms to 100,000 ohms and power ratings from 2 watts to 5 watts. All Fluke potentiometers utilize wire having a temperature coefficient of less than ±0.002% per degree Centigrade.

HIGH RESOLUTION VERNIER POTENTIOMETER

MODEL 20A



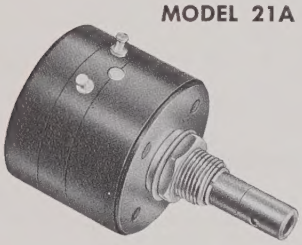


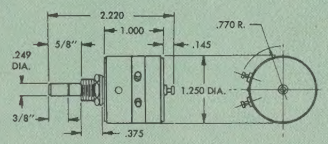
Resistance range, ohms	100 to 25K
Standard resistance tolerance	±5%
Available at	±1%
Min. practical resistance tolerance	±0.5%
Resolution 1K & above better than	0.02%
Standard linearity	±0.5%
Available at	±0.25%
Frequency range	DC to 100 KC
Power rating, watts	2 at 20°C
derated to	0 at 100°C
Equivalent noise resistance	less than 100 ohms
Electrical Rotation	550° ±10°
Mechanical rotation	562° ±10°
Price	$8.50

20A

HIGH RESOLUTION VERNIER POTENTIOMETER

MODEL 21A





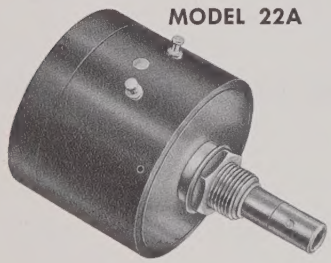
Resistance Range, ohms	30K, 40K and 50K
Standard Resistance Tolerance	±5%
Available at	±1%
Min. practical resistance tolerance	±0.5%
Resolution 30K and above better than	0.008%
Standard linearity	±0.5%
Available to	±0.25%
Frequency range	DC to 100 KC
Power rating, watts	3 at 20°C
derated to	0 at 100°C
Equivalent noise resistance	less than 100 ohms
Electrical rotation	550° ±10°
Mechanical rotation	562° ±10°
Price	$10.00

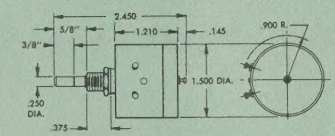
21A

7

HIGH RESOLUTION VERNIER POTENTIOMETER

MODEL 22A



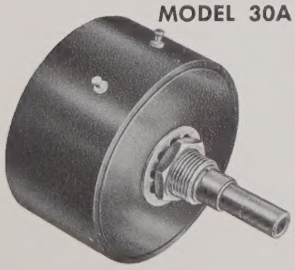


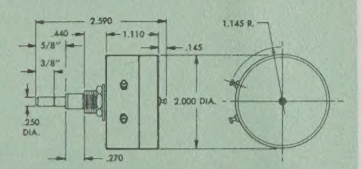
Resistance range, ohms	1K to 100K
Standard resistance tolerance	±5%
Available to	±1%
Min. practical resistance tolerance	±0.5%
Resolution 1K and above better than	0.02%
Standard linearity	±0.5%
Available to	±0.25%
Frequency range	DC to 100 KC
Power rating, watts	5 at 20°C
derated to	0 at 100°C
Equivalent noise resistance	less than 100 ohms
Electrical rotation	550° ±10°
Mechanical rotation	562° ±10°
Price	$15.00

22A

HIGH RESOLUTION VERNIER POTENTIOMETER

MODEL 30A





The Fluke Model 30A vernier potentiometer provides resolution better than available in 40 turn helical potentiometers in less than 2½ turns.

Resistance range, ohms	1K to 100K
Standard resistance tolerance	±5%
Available to	±1%
Min practical resistance tolerance	±0.5%
Resolution: 1 part in 50,000 or better than	0.002%
Standard linearity	±0.5%
Available to	±0.25%
Frequency range	DC to 100 KC
Power rating, watts	5 at 20°C
derated to	0 at 100°C
Equivalent noise resistance	less than 100 ohms
Electrical rotation	830° ±15°
Mechanical rotation	848° ±15°
Price	$30.00

30A

ACCESSORIES: COMPATIBLE KNOBS AND RESETTABLE DIALS AVAILABLE.

NEW POTS—NEW SOURCE

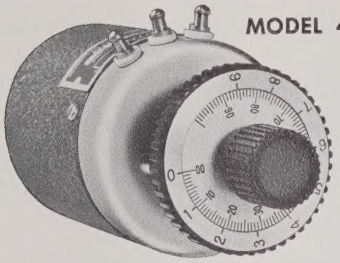
DECADE POTENTIOMETERS—NEXT PAGE

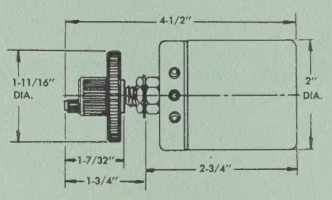
DECADE POTENTIOMETERS

John Fluke Decade Potentiometers are a family of precision voltage dividers consisting of a combination of high accuracy fixed resistors and a precision wirewound potentiometer. This combination provides linearity ranging from 1 part in 1000 to better than 1 part in 20,000 and resolution from 0.02% to more than 0.0002%. Wire having a Temperature Coefficient of less than ±0.0015% per degree centigrade is used in all Fluke Decade Potentiometers.

HIGH RESOLUTION DECADE POTENTIOMETER

MODEL 40A



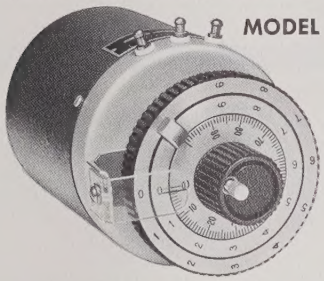


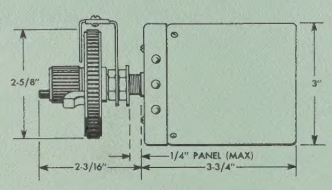
Voltage ratio in 0.001 steps	0 to 1.000
Standard input resistance, ohms (Other values available as specials)	1K to 10K
Standard resistance tolerance (full scale)	±0.5%
Resolution, better than	0.02%
Standard linearity (full scale)	±0.1%
Power rating, watts	3 at 20°C
Frequency response	DC to 100 KC
Available with 360° rotation	
Price	$48.00

4

HIGH RESOLUTION DECADE POTENTIOMETER

MODEL 50A





Voltage ratio in 0.0001 steps		0.0000 to 1.0000
Standard input resistance, ohms (Other values available as specials)		1K, 10K, 20K and 100K
Standard resistance tolerance (full scale)		±0.05%
Resolution, better than		0.002%
Standard linearity (full scale)		±0.01%
Frequency range		DC to 100 KC
Power rating, watts		5 at 20°C
Available with either stacked or coplaner dials.		
Also available with 360° rotation.		
Price	1K, 10K, and 20K	$ 90.00
	100K	$100.00

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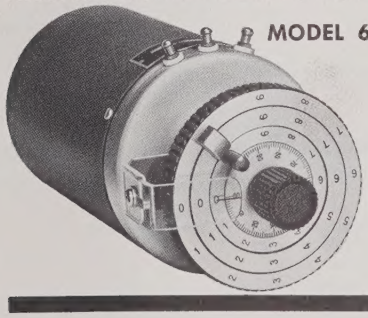
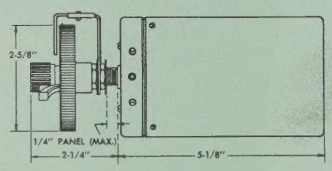
HIGH RESOLUTION DECADE POTENTIOMETER

MODEL 60A





Voltage ratio in 0.00001 steps		0.00000 to 1.0000
Standard input resistance, ohms (Other values available as specials)		10K and 100K
Standard resistance tolerance (full scale)		±0.05%
Resolution, better than		0.0002%
Standard linearity (full scale)		±0.005%
Frequency range		DC to 100KC
Power rating, watts		5 at 20°C
Available with either stacked or coplaner dials.		
Also available with 360° rotation.		
Price	10K	$145.00
	100K	$155.00

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FLUKE

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